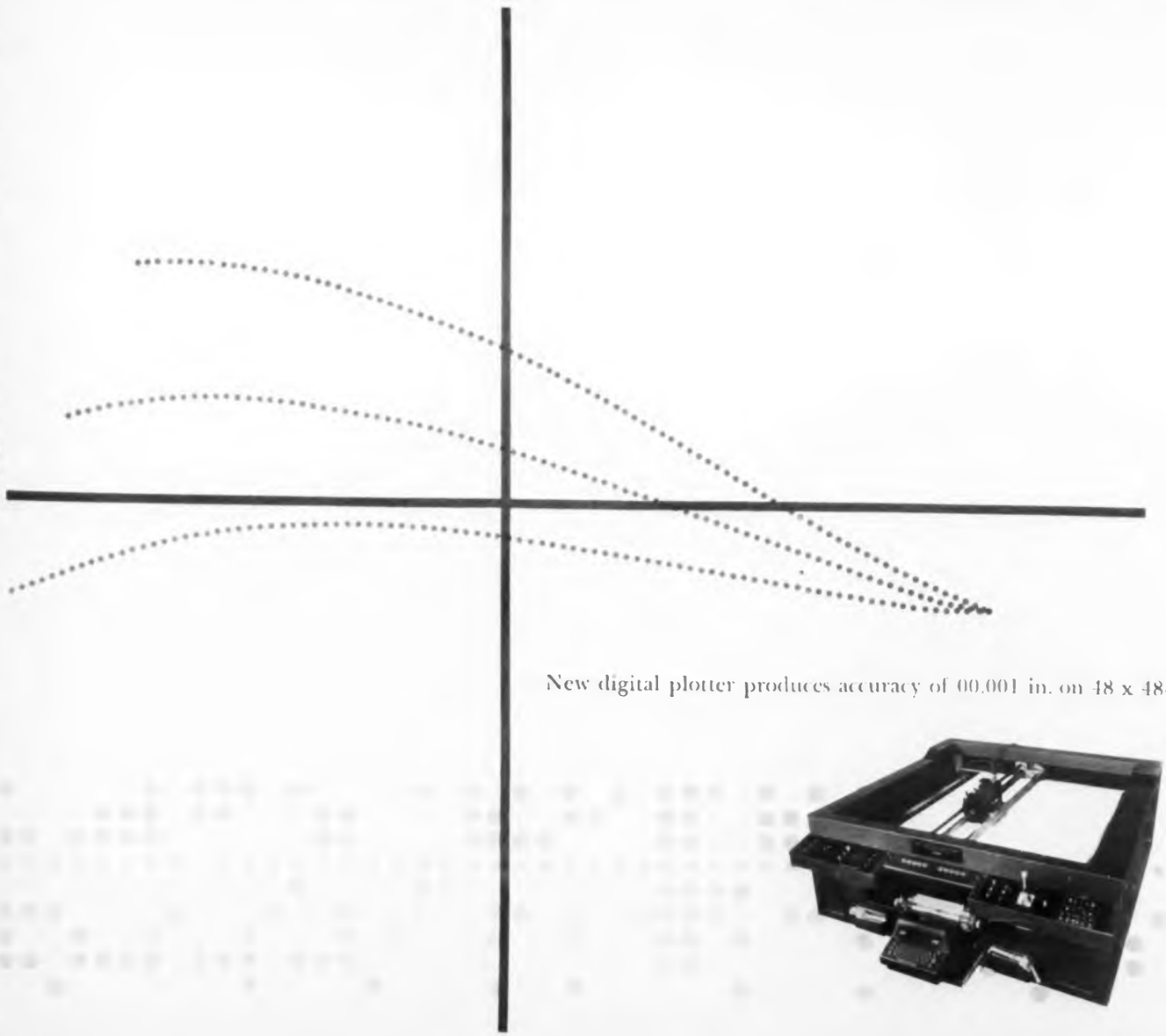
ELECTRONIC DESIGN

JANUARY 18, 1981



New digital plotter produces accuracy of 00.001 in. on 48 x 48-in. surface . . . p 50

ELECTRONIC DESIGN

COVER: Punched-tape information fed into the plotter causes the digital servos on each axis to move the head (red disk) in increments as small as 0.001-in. The ball-screw drives have enough "beef" for light machining operations such as marking or cutting plastic.

Selected Topics In This Issue

ELECTRONIC DESIGN · ONE DAY SERVICE

USE BEFORE MARCH 1st, 1961

Name ____________________ Title ____________________ A

Company ____________________

Company Address ____________________ City __________ Zone ______ State ______

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Sidelights of the Issue

Come to the Fair

The hodge-podge of print, pictures, and sweat that makes up the magazine business has been likened by novelist Theodore H. White to a fair. Since ancient times, he says, men have come together to buy and sell goods, trade gossip, absorb ideas, and sometimes get a little preaching done.

In a magazine, all this is still done, and while there always exists a certain amount of good-natured banter between editors and advertising men, editors never forget that the advertisers supply the fairgrounds where editors can swap gossip with and preach to readers.

In the light of this, we are especially proud of our 1960 advertising volume. In the last year, ELECTRONIC DESIGN moved ahead of all other electronic publications in total number of pages of advertising.

We are now fourth among all business and trade publications and fifth among all U.S.-published magazines.

Naturally, we know all this would be impossible without a group of people who could be brought into a community interested enough and enlightened enough to want to come to the fair. We and our advertisers gave our readers the fairground and fair; the readers have made it an ultimate success.

Doubling Reading Speed

On p 172 of this issue, there appears the second article in a series, "Cutting Your Reading Time in Half." The series, which is part of our continuing section, "Designing Your Future," was especially prepared for ELECTRONIC DESIGN by Myron Q. Herrick, vice president of the Developmental Research Institute, Inc., which specializes in industrial reading training. Mr. Herrick's byline was inadvertently dropped from the first article.

The Institute, an affiliate of the Reading Laboratory, Inc., provides package courses for training officers in both large and small companies. But a 64-page, do-it-yourself book, giving the how, what, and why of reading improvement, together with a self gauge for measurement, is available to individuals. The cost is $2 and it may be had by writing Developmental Research Institute, Dept. E-61, 500 Fifth Ave., New York, 36, N.Y.

KAY VIDEO FREQUENCY SWEEPING OSCILLATOR AND FREQUENCY MARKERS

- All electronic
- Stable
- Balanced output
- No phasing adjustments
- Zero reference line
- "Crystal" frequency-markers

The Marka-Sweep Model Video are beat frequency oscillators, carefully shielded and filtered to prevent spurious output signals. They provide crystal-controlled, fixed frequency markers, built in attenuators, and carefully balanced, low-harmonic output.

The *Marka-Sweep Model Video 50* is a wide range video sweeping oscillator which provides higher output voltage and sweeps *lower in frequency* than the usual wide range video sweeping oscillators. It provides a linear swept-frequency output, AGC'd for constant output over the frequency band. The *Marka-Sweep Model Video 50* includes a series of sharp pulse-type crystal markers. In addition, a calibrated frequency dial permits the use of the unit as an IF sweeping oscillator with continuously variable center frequency and sweep width.

50 kc to 50 mc

KAY
Marka-Sweep®

MODEL VIDEO 50

Catalog No. 153-B

Video & IF Coverage

High Output, Wide Sweep

Automatic Gain Control

SPECIFICATIONS

Frequency Range: Continuously variable, 50 kc to 50 mc.
Sweep Width: Linear, continuously variable, 4.0 mc to 50 mc.
Sweep Rate: Variable around 60 cps; locks to line frequency.
RF Output: Continuously variable, zero to 1.0 V, peak-to-peak, into nom. 70 ohms (50 ohms upon request). Flat to within ±0.5 db over widest sweep.
Attenuators: Switched 20 db, 20 db, 10 db, 6 db and 3 db steps plus 3 db (approx.) variable.
Markers: Eight sharp, pulse-type, crystal-positioned markers; usable singly or collectively. Produced either as positive pulses with separate amplitude control and separate output or as keying pulses in sweeping RF signal. Five markers, at 10, 20, 30, 40 and 50 mc, are standard. Substitute frequencies or (up to 3) additional frequencies on special order in the range of 10 mc to 50 mc.
Marker Amplitude: As positive pulse at separate output, continuously variable, zero to 3 V peak. As "negative" keying pulses, same amplitude as RF output.
Sweep Output: Regular sawtooth, synchronized with sweeping oscillator. Amplitude approx. 7.0 V.
Price: $845.00, f.o.b. factory. $930.00 F.A.S., New York. Substitute markers, $12.50. Additional markers, $20.00 each.

50 kc to 20 mc

KAY *Marka-Sweep*®

Model Video

Catalog No. 150-B

- 3 switched bands
- 6 fixed crystal markers
- Forms variable pulse-type marker from external video frequency generator

SPECIFICATIONS

Frequency Ranges: 50 kc to 5 mc; 50 kc to 10 mc; 50 kc to 20 mc.
Sweep Rate: Variable around 60 cps; locks to line frequency.
RF Output: 0.2 V rms into nom. 70 ohms. (50 ohms upon request.) Flat within ±0.5 db over widest sweep width.
Attenuators: Switched, 20, 20, 10 and 3-db, plus variable 6-db (approx.)
Markers: 6 sharp, pulse-type, "crystal" markers; provision for 1 variable.
Marker Amplitude: 5 V approx.
Sweep Output: Sawtooth, 7.0 V approx.
Price: $575.00 f.o.b. factory. $633.00 F.A.S. New York. Substitutions for standard markers. $12.50 each.

50 kc to 8 mc

KAY *Marka-Sweep*®

Model Video TTV

Catalog No. 151-A

- High, metered output
- Both crystal-controlled and variable . . . markers and/or CW signals

The *Marka-Sweep Model Video TTV* provides a choice of any one of five fixed crystal-controlled, birdie-type markers (or CW) and/or a calibrated marker (or CW) which is continuously variable over the frequency range.

SPECIFICATIONS

Frequency Ranges: Sweeping oscillator, 50 kc to 8 mc. Crystal oscillator, five switched frequencies at 200 kc, 750 kc, 1.25 mc, 4.0 mc, and 6.0 mc.
RF Output: Swept RF, variable CW, or crystal-controlled CW signals, 1.5 V rms into nom. 70 ohms, metered (50 ohms upon request). Swept RF flat within ±0.5 db.
Attenuators: Switched 20, 20, 10, and 3 db, plus continuously variable 6-db (approx.).
Marker Amplitude: 5.0 V peak.
Sweep Output: Sawtooth, 7.0 V.
Price: $795.00, f.o.b. factory. $875.00 F.A.S. New York. Substitute markers, $12.50 each. Cabinet $35.00.

WRITE FOR COMPLETE CATALOG INFORMATION

KAY ELECTRIC COMPANY

Department ED-1 Maple Avenue, Pine Brook, N. J. CApital 6-4000

CIRCLE 3 ON READER-SERVICE CARD

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ELECTRONIC DESIGN Hayden Publishing Co., Inc., 830 Third Avenue, New York 22, N. Y.

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What is your need for exactitude?... "over there at 3 pm" or "5000 yards/212° azimuth/70° elevation/15 hours, 22 minutes, 12.033 seconds PST." The Canoga Model 8476 Radar Telemetry Data Tie-In System provides digital radar determination of range, elevation and azimuth of an object in space with reference to time. A choice of signals generated internally are recorded at from one to 100 per second, stored in binary memory devices and are available as an input to computers, magnetic tape recorders, punched paper tape recorders, printers and other devices. Data printed out from computer processing give time of occurrence; polar and cartesian coordinates of one or more targets corrected for refraction, parallax and earth curvature; dX, dY and dZ of the targets relative to each other; 23 words, 14 bits each, of telemetered data; and more. With the Canoga Model 8476 it is possible to reconstruct a complete trajectory of a given target providing digital evaluation at any time. canoga

Canoga Electronics Corporation · Van Nuys, California · Fort Walton Beach, Florida

CIRCLE 4 ON READER-SERVICE CARD

Navy Discloses Details of Shipboard 3-D Radar

Hughes Device Incorporates Built-In Pitch-and-Roll Stabilizer, Varies Signal Frequency to Accomplish Electronic Scanning

DESIGN details of an electronically steered, three-dimensional radar for shipboard use have been disclosed by the Navy. The heretofore-classified Frescan (for frequency scanning) radar, in use for some time aboard guided-missile cruisers, was developed by the Hughes Aircraft Co., Fullerton, Calif.

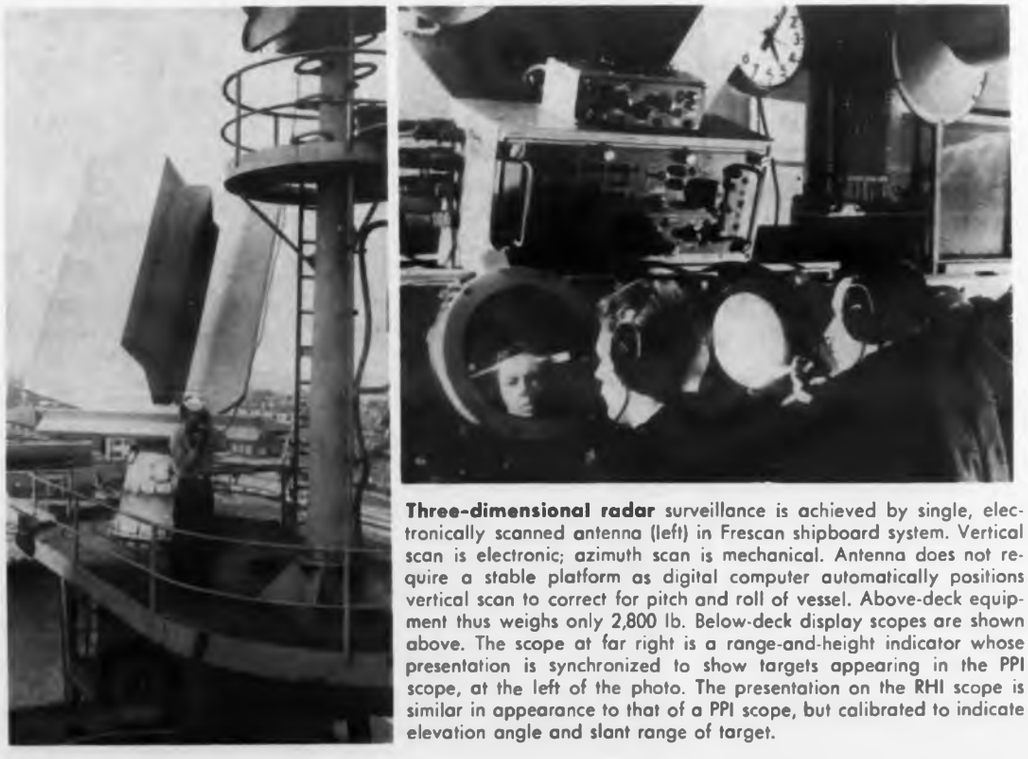
Frescan is actually a hybrid system; elevation of the radar beam is electronically steered, but scanning in azimuth is by mechanical rotation of the antenna. More advanced versions already at sea are, however, electronically steered both in azimuth and elevation.

Frescan also incorporates an electronic pitch-and-roll stabilization system. A digital computer, fed by the ship's main gyro, modifies the elevation and scanning pattern to compensate for ship's motion. A stable platform for the antenna is thus unnecessary and weight of above-deck equipment is reduced considerably.

Electronic scanning is accomplished by varying the frequency of the radar signal itself. The antenna consists of an end-fed, frequency-sensitive, 40-element linear array. Its output is a pencil-like beam whose elevation is a function of the input frequency to the antenna. Elevation can be varied through an angle of more than 100 deg with a frequency excursion of less than 10 per cent.

The frequencies are generated by a master oscillator consisting of 18 separate crystal oscillators. Crystal-generated frequencies are mixed by a computer-controlled electronic switching system. More than 200 different frequencies are thus extracted to effect vertical scanning. These frequencies also control the local oscillator in the receiver so that the intermediate frequency remains constant throughout the scan. Design of the crystal oscillators is straightforward, as ultra-stable frequency regulation is not required.

The frequency signal derived from the mixer is amplified in a traveling-wave tube and fed to a klystron final amplifier. The klystron is a multiple-cavity unit containing seven stagger-tuned cavities encompassing the desired frequency range. Power output is not linear with frequency, but is deliberately shaped so that power increases with frequencies corresponding to a lower beam angle.



Three-dimensional radar surveillance is achieved by single, electronically scanned antenna (left) in Frescan shipboard system. Vertical scan is electronic; azimuth scan is mechanical. Antenna does not require a stable platform as digital computer automatically positions vertical scan to correct for pitch and roll of vessel. Above-deck equipment thus weighs only 2,800 lb. Below-deck display scopes are shown above. The scope at far right is a range-and-height indicator whose presentation is synchronized to show targets appearing in the PPI scope, at the left of the photo. The presentation on the RHI scope is similar in appearance to that of a PPI scope, but calibrated to indicate elevation angle and slant range of target.

Scan Rate and Power of Radar Automatically Varied with Range

Since Frescan operates with Terrier and other anti-aircraft missiles, target range will increase as the beam approaches the horizon. Thus, for targets near the zenith, power of the main bang can be reduced.

Other aspects of the system are also programed to vary according to the angle of beam above the horizon. Again, the assumption is that targets nearer the horizon will be more distant than those near the zenith. Thus, pulse repetition frequency decreases as the beam descends and the rate of descent is slowed as the beam approaches the horizon. The ratio of prf variation is approximately 5 to 1. The rate of vertical scanning corresponds to a mechanical antenna rotation of several hundred rpm. The ratio of vertical scan rates is on the order of 20 to 1.

Frescan's display consists of a PPI scope for target azimuth and an RHI presentation for target range and height. Because of the system's three-dimensional capability, these displays are obtained by a single transmitter, receiver, and antenna. Conventional radar systems require a complete set of equipment for each scope.

Although Frescan has been in use since 1957, range, power, and frequency of the system are still classified. The frequency-scanning technique was developed by Dr. Nicholas A. Begovich, who is assistant manager at Hughes' Ground Systems Div. ■ ■

Thin Silicon Wafers Used In Fixed Digital Memory

Storage of 70,000 Bits per Cu. In. Points Way to Space Applications

THIN silicon wafers imprinted with ion-deposited conducting paths form the basis of a fixed digital memory with a claimed storage density of 70,000 bits per cu in. Development of the Silicon Permanent Array Memory is being pushed by the Librascope Div. of General Precision Instruments, Glendale, Calif., with an eye towards application in space-vehicle computers.

In its present experimental configuration, the memory consists of a number of 1-in. wafers, 0.008 in. thick, which are stacked to provide the required memory capacity. With present techniques, each wafer can be imprinted with up to 1,000 conducting paths—each path representing a stored bit. The paths are formed by fabrication of diodes and by deposition of appropriate dopants on the surface of the wafer. The contents of the memory are thus written in during the manufacturing operation and cannot be altered thereafter.

In many applications, however, this lack of flexibility is said to be inconsequential. Permanent storage can absorb up to 95 per cent of a memory's capacity, according to Robert Williamson, Librascope's director of military sales. Storage of programs and constants in guidance computers should be a likely application of the silicon memory, Mr. Williamson said.

Storage Density May Double With Further Development

In the "Centaur" space-vehicle-guidance computer, for example, 65,000 bits of permanent storage are written on a 6 x 6-in. magnetic drum. Librascope engineers hope to incorporate a 1-cu-in. silicon memory for this purpose in future space computers.

Present laboratory models of the memory are assembled from wafers which are imprinted on only one side. Since the conducting paths are entirely along the surface of the wafer, imprinting on both sides may prove feasible. Through this and other techniques, Librascope hopes eventually to double the presently claimed storage density of the memory.

Interconnections between wafers and access to the memory itself are by means of wires welded along the edges of the wafer stack. In general, the path for any particular bit is confined to a single wafer, but more complex paths extending across several wafers are sometimes necessary. Geometry of the paths and stacks is such that

NEWS

less than 100 access leads are needed for a 70,000-bit memory.

Nevertheless, interconnections are proving to be the major problem in the development of Librascope's memory. Since the wafer itself is of silicon, connection with a dissimilar metal creates semiconducting junctions tending to interfere with the conduction path. Gold and other inert metals are being tested for use in connections.

Manufacture May Be Uncomplicated Despite Micromin Design

Despite the micromin design of the memory, its manufacture may prove to be a relatively painless operation. Each wafer constitutes only a small part of the device and rejects would thus be in terms of the smaller unit rather than of the larger memory as a whole. Even, here, Librascope reports "surprisingly good" results. "The very first wafer we made had 193 good bits out of 195," Mr. Williamson said. That was last fall, and reject rate has reportedly since been cut further.

Each conduction path includes a diode which is formed from the surface of the silicon wafer. Diodes are separated from each other by an etched-grid pattern on the wafer. Conduction paths are then deposited from the diodes to the perimeter. The wafers are sandwiched between thin layers of insulating material, stacked, and interconnected. This structure is apparently quite stable and rugged, and, with its lack of moving components, should prove quite reliable.

Typically, a "1" bit would be a conducting path across the silicon wafer; a non-conducting path

First stage in manufacture of the Silicon Permanent Array Memory. The wafer constitutes one plane of the memory stack. Each dot is a diode formed on the surface of the silicon wafer. Diodes are then separated by etched grids and conducting paths are deposited from each diode to the edge of the wafer. Unit shown is 1-in. across and 0.008-in. thick.

would constitute a "0" bit. Resistance ratio between conduction and non-conduction is on the order of 2,000 to 1. Current drain per bit is said to be approximately 1 milliwatt. This characteristic would be highly desirable for long-term operation in a space system.

Good Temperature Range, Fast Access Claimed for Device

Access time is claimed to be in the microsecond range and there is no crosstalk between conducting paths. Temperature characteristics, as with most silicon devices are quite good. Operation between −60 and +100 C is reported possible. Radiation resistance is also reportedly good. Librascope engineers stated that a quick trip through the Van Allen belts should not have any adverse effect on the memory. For more intense radiation environments, the small size of the memory would appear to make shielding a reasonable possibility.

In addition to the memory's possible use in Centaur, other space vehicle applications are also likely. The memory has been proposed to the guidance laboratories of NASA's Marshall Space Flight Center, Huntsville, Ala., for use in Saturn, Nova, and other next-generation space vehicles. Dr. Walter Hausermann's group is presently evaluating the device and may reportedly come up with some definite plans within the next month. The memory proposed for Saturn will have a bit density considerably greater than 70,000 bits per cu in.

Potential users have been quoted 18- to 24-month delivery times. Price (in quantity runs) is expected to be "a small fraction of the cost for an equivalent core memory," according to a Librascope source. ■ ■

Russians Announce Optical Maser, Says Theirs Came Before U.S. First

Russian physicists have developed a new type of optical maser using a combination of mercury and zinc vapors, according to a paper in a recent issue of Soviet Experimental and Theoretical Physics.

Mercury-gas discharge lines provide the pumping light for zinc, which is the active material. Output is at 6,263 A and amplification factors up to 10 are reported.

The Hughes maser, first in the U.S., was described in late June, 1960. The Soviet demonstration, according to the magazine, occurred earlier than this.

Optical Reader Uses 35-Point Photocell Matrix

Positive and Negative Weighting of Matrix Points Increases Accuracy of Developmental RCA Reader

OPTICAL character recognition at speeds above 1,000 characters a second is being accomplished with a page reader now in prototype form at Radio Corp. of America's Product Development Laboratory, Pennsauken, N. J.

The new RCA machine reads a special type font, which includes 51 alphanumeric and special characters, through the use of a 35-point photocell matrix. A line of seven photocells gives the vertical dimension of the matrix, and five samplings of photocell outputs during the passage of a character under the reading-head adds the horizontal dimension.

RCA plans to install this machine for use in an experimental subscription-order system in February. Other field installations will follow. However, a commercial optical-reading equipment line will probably not be introduced until the end of the year, according to A. H. Stillman, manager of special-purpose equipment planning at the laboratory.

The page reader developed by RCA reads 8.5 x 11 in. documents, with 20 lines of up to 100 characters each, printed along the long dimension. These pages move onto a rotating drum at a rate of 12 per minute for reading. This is accomplished on a modified Addressograph-Multigraph paper-handling machine which has a reading head, two bright light sources on either side of the drum, and the necessary electronics added.

A movable reading head on a horizontal track rides just above the rotating drum. The head moves at a steady rate, in synchronism with drum rotation. The documents are passed onto the drum with a slight skew, so that printing remains under the moving head as the drum rotates. The skew angle is set so that a new line comes under the reading head with each drum rotation.

Reading of a character is initiated when at least two photocells detect dark black marks. The leading edge of each character in the RCA font is designed to give a black indication to at least two photocells in the seven-cell array.

After this initiation signal, four more discrete sampling intervals are timed. Timing is synchronized with drum-rotation speed so that the five samplings set up the horizontal dimension of the identification matrix.

Because of the shape of the character being read, certain of the points in the resulting 35-point matrix will indicate a black input, and others a white input to the photocells, as shown in the diagrams. These indications are accumulated in a storage register until the five timing intervals have passed, and are then shifted into a set of "map-matching" circuits.

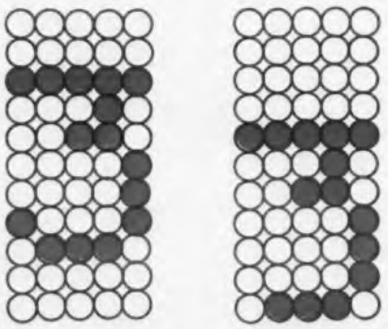
One circuit is used to represent each of the 51 characters in the font. When the actual 35-point matrix is compared with each of these stored matrices, a best-fit is sought by a logical network. The stored matrix which most closely resembles the one to be identified indicates the character being read.

Truth Table, Optimized on RCA 501, Increases Accuracy of Identification

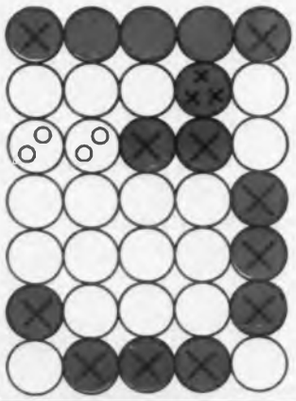
In order to increase accuracy of identification, a truth table with positive and negative weighting factors applied to critical points in each stored matrix was prepared. The finer points of this table were worked out on an RCA 501 computer to optimize weighting factors.

An example of these weighting factors, for the numeral 3, is given in Fig. 2. The crosses in some matrix position each represent a positive point, and the zeros a negative point.

Since the other stored matrix most closely resembling the 3 is that for the numeral 5, the weighting factors selected are aimed at preventing a smudged or poorly printed 5 from being misidentified as a 3. Thus three matrix points at



Reading sequence is illustrated as numeral 3 passes under the read head (left edge of the letter is actually read first). Seven vertical photocells, feeding their inputs to a storage register, are used to set up the character matrix. A row of 11 is used, however, to provide for possible vertical misalignment (actually two 11-cell sets are used so that all possible gaps are filled). Sampling at five timed intervals set up the horizontal dimension of the matrix. Only the bottom seven positions in the storage register have entry to the map-matching circuits used to recognize the character, therefore the character is shifted to these positions after the complete matrix is stored in the register, as illustrated at right. Note that the left edge of each character gives a black indication to at least two photocells, indicating when reading should begin.



Truth table worked out for recognition of each character includes both plus and minus weighting factors. The crosses represent positive points, and the zeros negative points. In the case shown for the 3, the weighting factors are primarily directed at preventing the reading of poorly printed 5 as a 3.

Varying positions of elements in similar letters increases the ease of recognition. The central bar on the E and F are examples of this approach.

Basic type font used with RCA developmental optical reading machine includes all letters and numerals, and also special symbols which are not shown. Special keys on an electric typewriter are used to prepare input documents.

the top of the 3, which also appear in a 5, are not even used in making the identification.

Another critical position, however, which does appear in the 3 but not the 5, is assigned a value of +3 points. Two matrix positions, which would indicate black in the 5 but not in the 3, are given two negative points each.

After the matrix to be identified is matched against each of the stored matrices a sum based on the weighting factors results. The machine will identify the character being read according to the stored matrix which matches the unknown matrix with the highest score.

If the second highest score is too close to the first, however, a reject results for that line on the document. A reject mark is automatically printed at the end of this line to indicate to the operator that a character in that line could not be identified properly.

Another factor increasing accuracy with the RCA machine is the use of an electric typewriter for preparing all documents. Since this gives a very even blackness to the characters, the quantizing level—or level below which the photocell output must fall to indicate a black area—can be set quite high.

Undetected Error Rate Is 1 Character in 100,000

Using this type input document, the machine is now giving an undetected error rate of about 1 character in 100,000, according to Mr. Stillman. A goal of 1 undetected error in 1 million characters is being set for improved versions of the reader, he added.

A check of recognition accuracy is made before reading each document. This is done with a set of control characters at the left edge of the drum. When the read head completes the reading of a page, it returns to the left edge and reads the control set before beginning the next document. Checking circuits monitor recognition accuracy during this pass. ■ ■

CIRCLE 8 ON READER-SERVICE CARD ➤

NEWS

Radio Astronomy Satellite

Improved Communications Possible With Profile of Ionosphere Density

VALUABLE fringe benefits for electronic designers are expected from a radio astronomy satellite being designed at Harvard University. A payload to be orbited late this year will measure cosmic radio noise below 13 mc, to which the ionosphere is largely opaque. Coded, low-frequency ground transmissions and a highly eccentric satellite orbit will at the same time yield a profile of ionospheric density and perhaps indicate the existence at those frequencies of "windows" useful for communications.

First step in the project, sponsored by the Air Force's Cambridge Research Center, is a rocket flight from Cape Canaveral due this month for a quick, half-hour look at the cosmic noise spectrum. The "Scout" vehicle will carry four transistorized tuned radio frequency receivers set at 0.7, 2.2, 7.0 and 13.25 mc. Each receiver will be temperature-protected to maximize frequency stability and will include a thermistor to measure internal temperatures. Received signal strengths and temperatures will be telemetered to the tracking station.

Antennas will consist of four 10-ft telescoping rods. Each rod, with appropriate loading coil, will serve one receiver. Antenna efficiencies at these frequencies are rather low; receiver sensitivity is therefore boosted accordingly. According to Harvard's Prof. Edward Lilley and G. R. Huguenin, in charge of the project, the cosmic-noise spectrum will have an equivalent black body temperature of approximately 1 million K. Receivers have a noise figure of about 3 db and are designed for good stability of bandwidth and gain with changing temperature.

Ground-Based Equipment to Check Leakage and Background Noise

Four transmitters on San Salvador Island will broadcast coded pulses on each of the four selected frequencies at 5-deg intervals of the rocket's trajectory. Four ground receivers, equivalent to those in the rocket will also be monitored during flight.

The coded transmissions will be used to determine the extent of low-frequency leakage through the ionosphere. The ground receivers will monitor terrestrially generated background noise so that the spaceborne measurements can be corrected for any ionospheric leakage that may exist.

Since the rod antennas aboard the rocket are

To Measure VLF Energy

necessarily omnidirectional, the actual mapping of radio stars will not be possible. Measurements will indicate the total incoming intensity at the various frequencies.

Satellite Directional Antennas May Be of Novel Design

Plans for future satellites, however, call for more directional antennas. These may well be of the log-periodic type. Professor Lilley would like to see true dipoles aboard the satellites in the near future. These would be on the order of 1,000 ft across.

The problem of erecting such structures in space has yet to be solved. However, DeHavilland Aircraft, Downsview, Ont., is experimenting along the following novel lines. A spring-loaded steel tape (much like a carpenter's ruler) would be unreeled through a die. This die would extrude the tape into a relatively rigid section, such as a cylinder. In an essentially force-free field, these structures are self-supporting.

Receivers aboard the satellites will also be more sophisticated. Sweep-frequency rather than fixed-frequency units will be carried to monitor the spectrum down to 100 kc. To assure temperature stability, a Dicke-type circuit is planned. In this circuit, the receiver switches periodically between the antenna and an internal calibrating load. The signal from the load automatically compensates the receiver for any temperature-induced gain fluctuations.

Payload Will Be Carried On Military Satellite

The satellites are scheduled to be launched from Vandenberg Air Force Base, Calif., by military rockets. The cosmic-radio payload described here will probably hitch a ride with other military space experiments. The same scheme of ground receivers and transmitters to be used for the initial rocket experiment will be continued with the satellite.

These scientists know, for example, that the planet Jupiter emits signals in the 10- to 20-mc range, but they have not as yet been able to measure the frequency spectrum from the ground.

Radio astronomers expect that the satellites will yield much valuable data on solar prominences, cosmic-ray electrons, and magnetic fields in space. Noise outbursts from the sun and the planets will also be studied.

The experimental concept and payload design are the result of a three-year feasibility and study program conducted with Air Force backing. ■ ■

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TV, Photomultipliers to Aim Stratoscope II

Pointing Accuracy of 1/20th Sec of Arc Expected; Automatic On-Board Focusing a Design Feature

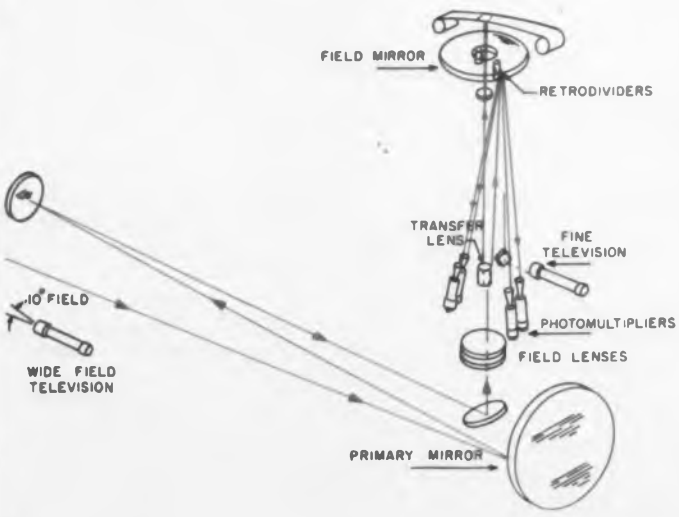
Complexity of Stratoscope II is shown in this model of the payload. Long arm of the L-shaped instrument extends 25 ft; shorter arm is nearly 19 ft long. Circular structure at top houses storage batteries. The 36-in. reflector is at rear of the right-hand tube. The 4,300-lb payload is floated on a mercury bearing. A mid-air recovery system employing helicopters is being developed to minimize damage on landing.

A UNIQUE system of electronic pointing and focusing is being designed to control the Stratoscope II balloon telescope, due to be flown late this year. A four-step aiming procedure, combining television cameras and photomultiplier tubes, is expected to achieve a pointing accuracy of 1/20th sec of arc for the 4,300-lb unmanned payload.

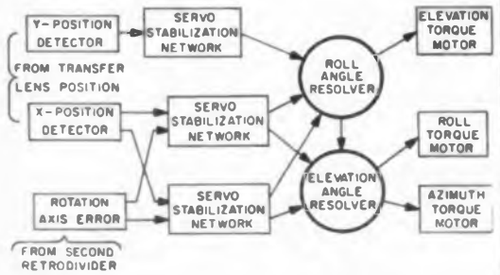
The 36-in. reflector is a follow-on to the highly successful Stratoscope I, which gave astronomers their first look at the sun unobstructed by atmospheric turbulence and dust. Likewise, Stratoscope II will provide increased resolution of planets, stars, and nebulae from its 80,000-ft high vantage point.

The Perkin-Elmer Corp., Norwalk, Conn., builder of Stratoscope I, is also responsible for the optics and control system for the second vehicle. Dr. Martin Schwarzschild of Princeton is in charge of the project, which is being funded by the office of Naval Research, the National Science Foundation, and NASA. Dr. Vladimir Zworykin of Radio Corp. of America's Sarnoff Research Center is heading television-system design for Stratoscope II.

The Stratoscope Assembly is suspended from a 200-ft. diam Mylar bag. The payload floats on a mercury bearing that permits 360-deg rotation



Electronics and optics are combined to aim and focus the 36-in diam reflector in Stratoscope II. Wide-angle and fine TV cameras are used in initial stages of aiming. Thereafter, photomultipliers zero in on reference stars through a servo system. Servos also control telescope's focus by driving to achieve sharpest possible image of reference stars.



Telescope-aiming system uses information derived from transfer-lens position and second retrodivider. Signals are cross-coupled, resolved into components along mechanical axes of the telescope and fed to torque motors. The simplified diagram shown here omits the separate servo associated with positioning of transfer lens and focusing mirror.

in azimuth. Special flexture bearings, designed to exert no restoring force on the load, permit limited motion in the remaining two degrees of freedom. Fine control forces are developed by three torque motors, one per axis. Coarse control is by means of two geared motors; the mercury bearing supporting the azimuth axis permits both coarse and fine control forces in that direction to be developed by the same motor.

All Phases of Aiming Procedure Can Be Controlled from Ground

In aiming the Stratoscope, two reference stars are used. These are generally on opposite sides of the field of view to be observed and can be as dim as eighth magnitude. All phases of the aiming routine may be monitored and controlled at the ground station by radio command links.

Reference stars are initially acquired by a wide-angle TV camera having a 10-deg view of field. The camera employs an RCA C74034 image orthicon. This 3-in. tube is a developmental unit designed at the company's Lansdale Div. for other applications. The TV picture has a resolution of 450 lines and is transmitted at 20 frames per sec over a uhf channel. The telescope is rotated to center the two reference stars in the wide angle camera; this initial step in aiming gives an accuracy of about 0.5 deg. Aiming control then passes to the second, narrow-angle TV camera.

Second Camera Internal, Fed by Telescope Optics

Unlike the first camera, which sights along the barrel of the telescope, the second camera is internal, and is fed by the optics of the telescope

itself. Except for its 1-deg field of view, it is essentially identical to the first unit. Aiming accuracy with the second camera is on the order of 1 min.

At this point, the photomultipliers and associated optics are brought into play. A separate cluster of four RCA 7265 photomultipliers is provided for each of the two reference stars. A servo system fed by the tubes drives the telescope so that the detected energy from each star is distributed equally among the four photomultipliers. By maintaining this condition, the system compensates for the earth's rotation, winds aloft, and other disturbing forces.

Each photomultiplier cluster is fed by a retrodivider, or four-way beam splitter. This device is a cube-corner prism so designed that the outgoing rays remain focused on the photo tubes regardless of prism travel. This is necessary because each prism is mounted on a two-degree-of-freedom carriage and may be positioned at will within the telescope's field of view.

The beam splitters move in front of a calibrated background screen. After the reference stars are centered in the narrow-angle camera, a lamp is switched on inside the telescope to illuminate the beam splitters and background screen. These are viewed by the TV camera and the beam splitters are moved by ground command to preselected positions within the telescope. Their locations correspond to where the designated reference stars will appear in the telescope's field.

Telescope Acquires Reference Stars After Beam Splitters Are Adjusted

Once the beam splitters are adjusted, the light is extinguished and the telescope is rotated, again under ground control, to acquire the reference stars. This third step in the aiming sequence is accurate to within 0.2 sec of arc.

Since each phototube cluster has an effective viewing angle of about 1 min, initial acquisition by the beam splitters does not necessarily center the reference star in the cluster. At this point an error servo, driven by the combined output of the phototubes, assumes control to center the reference stars. This final step, accurate to 0.05 sec permits exposure times of several hours for extremely faint objects.

Phototube output is linear, however, only over a very narrow portion of the one minute field. During initial acquisition and correction of large errors in reference star position, the servo must therefore operate with a saturated error signal. Circuitry of effective operation under these circumstances has been developed by Perkin-Elmer but, according to project engineer Harold Hem-

street, "Design details of the servo are proprietary and cannot be described at this time."

Images, Not Telescope, Move To Accomplish Fine Pointing

Fine pointing is accomplished essentially by moving the image rather than by moving the telescope. A two-degree-of-freedom transfer lens in the optical system is driven by the servos for this purpose. The position of the transfer lens then indicates angular errors about two of the telescope's optical axes. As shown in the accompanying diagram, the transfer lens is driven by one set of phototubes and denotes errors with respect to only one of the reference stars. Errors with respect to the third optical axis are derived from the second reference star and its associated beam splitter and phototube cluster. The angular errors are then resolved into errors with respect to the telescope's mechanical axes and fed to the error correction motors.

Focusing of the telescope is also performed by the servo system. The condition for optimum focus is that servo gain be maximum. At this point, the stellar energy impinging on the phototube cluster is concentrated into the smallest possible area. Accordingly, a small position error will result in the largest possible electrical response. The servo drives a focusing mirror in the telescope so as to satisfy this condition.

Seventy Command Channels Will Be Used by Ground Control

Ground control of Stratoscope II will utilize 70 command channels. Functions will include adjustment of the image orthicons and TV system, coarse focusing and pointing, insertion and removal of color filters, and payload release. A telemetry system from Sierra Research, Buffalo, N. Y., will also be on board.

Stratoscope II will remain aloft approximately 10 hours during each flight, after which the payload will be detached and parachuted to earth. A mid-air recovery system employing helicopters is, however, being developed to reduce possible damage in landing. But even in Stratoscope I, Dr. Schwartzschild told ELECTRONIC DESIGN, repairs necessary after each landing averaged about 5 per cent of payload cost. In general, the survival capability of the electronic equipment was even better, and Perkin-Elmer is taking no unusual measures to ruggedize the electronics for Stratoscope II. Tests and recovery of a dummy payload are scheduled soon.

As in Stratoscope I, the telescope will expose photographic film which will be recovered and developed. Future plans, however, call for a live return of astronomical data from the telescope. RCA has initiated design of analog TV equipment for this eventual application. ■■

NEWS

Welded, Imbedded Units

Thin-Film, Molecular Approaches To Take Lead Later, Poll Predicts

CORDWOOD modules and imbedded circuits will be the leading microminiaturization approaches over the next few years, according to majority opinion in an industrywide survey of workers in the field.

The majority also felt that thin films, Solid Circuits, and molecular approaches will take the lead in the 1965-70 period. The survey, conducted by P. R. Mallory & Co., Inc., Indianapolis, Ind., consisted of a series of detailed questions on the micromin field. A group of 16 major approaches were ranked by respondents according to adaptability to important micromin factors.

Mallory received 98 completed questionnaires, or about 20 per cent of those distributed.

A composite rating was obtained, for each factor under which approaches were ranked, by assigning 11 points to a first-place selection, 10 points for a second-place choice, and so on.

Integrated Molecular Lead in Reliability; Imbedded Circuits Lead in Flexibility

For inherent reliability, Texas Instrument Solid Circuits took first place in composite standings, with Westinghouse molecular electronics second. Only 14 first-place votes went to the TI approach, however, while molecular circuits received 21. The cordwood approach was third in composite standing, and thin-film approaches took fourth place.

The cordwood technique, or welded-module approach, led in composite standings for inherent design flexibility. Mallory's Unitized Component Assembly concept and Hughes Dot circuitry, both approaches in which pellet or radial lead components are imbedded in circuit boards, were second and third respectively. RCA micromodules were fourth in this category.

The cordwood approach was also judged most practical with regard to cost versus reliability. Mallory's UCA concept was second, RCA micromodules third, and Hughes Dot circuitry fourth in this category.

RCA micromodular technique was selected as the best method for adaptability to automation techniques. Second was Mallory's approach; third, thin films; and fourth, Hughes Dot circuitry. Significantly, however, 25.5 per cent of the respondents indicated that automation factors are not important in microminiaturization, considering the potential quantities and cost factors involved. Of the remaining contributors, 63.3 per cent felt that automation is important, and

Top Micromin Survey

11.2 per cent did not answer this question.

For interconnections between individual components and modules, the cordwood technique again took the lead, with Mallory, Hughes, and RCA micromodules following. The order was the same for interconnecting into complete equipment, except that the RCA approach dropped to fifth place, and the Burroughs Macro Module approach moved into the fourth spot.

Over-all predictions placed the cordwood approach in first place for the 1960-61 and the 1962-65 periods, with the Hughes and Mallory approaches second and third in both intervals. RCA micromodules were fourth in 1960-61, with thin films fifth and the Amp Meca system sixth. During 1962-65, the consensus predicted that thin films would take over fourth place, with TI Solid Circuits fifth and RCA micromodules sixth.

In 1965-70 it was felt that thin films will take over the first spot, with Westinghouse molecular circuits second, TI Solid Circuits third, and a similar integrated approach—Fairchild Micrologic blocks—in fourth place. Hughes Dot circuits were fifth, and Mallory's approach sixth.

By 1970-75, the authorities placed the molecular electronics approach in first spot, with TI Solid Circuits second and thin films third. Fourth in this period was Fairchild's Micrologic blocks, and fifth, Hughes Dot circuits. IRC Mu-circuits, a thin-film approach, moved into sixth place for this interval. ■ ■

Approaches Considered In Mallory Survey

Respondents were asked to rank various microminiaturization approaches according to particular micromin factors. The following 16 approaches were considered in the Mallory survey (for detailed descriptions of approaches see "Guidelines to Microminiature Designs," *ED*, Nov. 9, 1960, p 61.):

Amp Meca system; Burroughs Macro Modules; cordwood techniques; Fairchild Micrologic elements; GE Timm concept; Aerovox Corp., Hi-Q Div.'s Microcircuits; Hughes Dot circuitry; IRC Mu-circuits; Mallory Unitized Component Assembly approach; Micram or 2-D approach; RCA micromodule system; Sprague ceramic-based microcircuits; Sylvania microminiature modules; thin film techniques; TI Solid Circuits; and Westinghouse molecular electronics.

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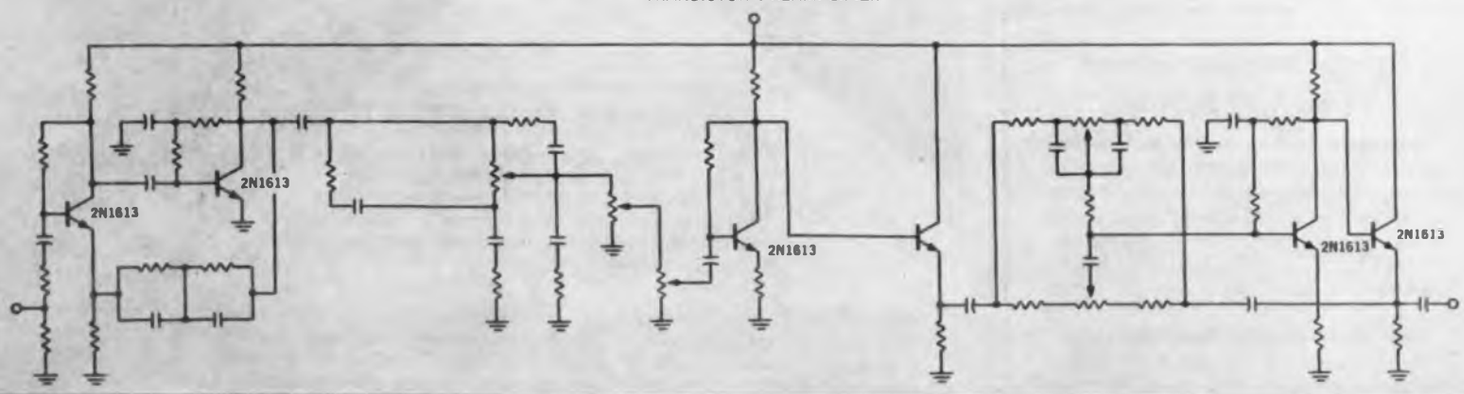

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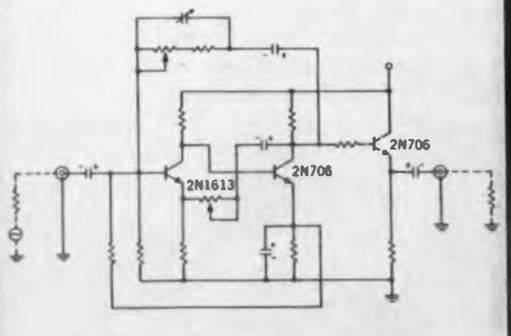
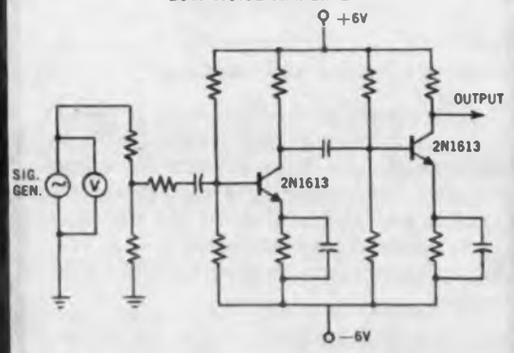
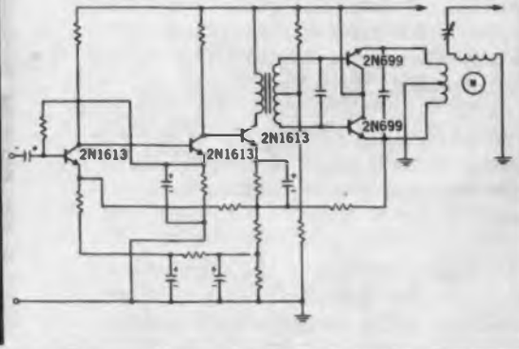


LOW NOISE AMPLIFIER



EQUIVALENT INPUT NOISE VOLTAGE < 20μV P.P.

2 WATT SERVO-AMPLIFIER



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CIRCLE 16 ON READER-SERVICE CARD

NEWS

Linear Accelerators

Flash Tests of Missile Electronics Accomplished with Hughes Device

MISSILE electronic systems are being tested with a simulated nuclear burst created by a new linear accelerator at White Sands Missile Range, N.M.

The linac used for the flash tests was built for the Army by Hughes Aircraft Co., Culver City, Calif. It produces a single high-intensity burst of about 10 million v of gamma radiation at variable pulse widths, allowing evaluation of nuclear explosion effects on missile systems without use of an expensive reactor.

Pulse widths in the Hughes single-pulse linac can be varied from 0.25 to 10 sec by turning a knob on a control panel.

Two 5-Megawatt Klystrons Provide Accelerator Energy

Two 5-megawatt klystrons feed microwave energy into a 30-in. high-vacuum accelerator tube. Electrons injected into the chamber by an electron gun are accelerated through interaction with the microwaves.

As the beam leaves the accelerator tube it strikes a heavy metal target, such as one made of tungsten, producing the gamma-radiation pulse.

In addition to the military application, Hughes scientists said their linac has other important potentials in the use of atomic energy by industries, research institutes, and universities conducting nuclear research. They said linacs could be used in medicine, pharmaceutical processing, plastics, chemistry, petroleum, physics, radiography, biology, and polymerization. ■ ■

Microwave energy for accelerating electrons in the 30-in. accelerator chamber is provided by two 5-megawatt klystrons, linked to the chamber by a waveguide in the background. Lucite disk has been exposed to a high-energy gamma-radiation pulse.

Find Many Uses

Up to 8 Million Electron Volts Used In X-Ray Machine for A. O. Smith

A LINEAR accelerator employing 8 million electron volts and generating 6,000 roentgens per min has been developed for radiography in the metals industry.

The linac, now being built by High Voltage Engineering Corp., Burlington, Mass., will be installed next spring in the Milwaukee plant of the A. O. Smith Corp. It is designed to be able to X-ray steel more than a foot thick and to furnish photographic proof of the soundness of such metal structures as core barrels for nuclear reactors and high-pressure vessels for the petrochemical industry.

The device differs from other radiographic equipment in that it produces its X-rays by "firing" high-energy electrons in a straight line down an evacuated tube. The electrons are impelled by traveling radio-frequency waves. These pulses accelerate the electrons until they approach the speed of light. At the tube's end, the electrons strike a tungsten target and produce X-rays which are beamed onto the material to be examined.

X-Ray Source Will Provide Choice of Focal-Spot Sizes

The A. O. Smith-High Voltage linac will be equipped with an X-ray source providing a choice of 1-mm and 5-mm focal-spot sizes. Respective outputs are 1,500 and 6,000 roentgens per minute.

At full power and at a distance of 9 ft, the 5-mm source will X-ray 11 in. of steel in about 1 min, or 16 in. of steel in about 18 min. The smaller source provides even greater resolution. It will radiograph 8 in. of steel in 1 min, or 14 in. in 30 min.

To insure the greatest possible reliability, the main power tubes will need to operate at only one third of their rated capacity to produce the maximum requirement of roentgens.

Device Said to Be World's Biggest X-Ray Machine

To house the Smith linac, a building with 6-ft thick concrete walls is under construction at the company's installation in Milwaukee. Smith engineers said the device was, in effect, the world's most powerful X-ray machine of its type.

The linac itself, indeed, resembles a huge X-ray machine and is operated in much the same way. ■ ■

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simplifies, economizes digital system design

Based on a series of 5 Mc transistor switching circuits in time-saving, plug-in "building block" form, Sprague Logiline circuitry performs digital functions including combinational logic, temporary storage, pulse source, and pulse amplification.

Sprague Logipak® encapsulated packages have standardized configurations—ideal for prototype design, equally suitable in final production—and they're smaller and priced lower than conventional wiring board assemblies.

Sprague Logicard® epoxy-glass etched wiring board cards have 22-pin connectors in aluminum frames which insert into pre-wired rack mounted panels. They are fully interchangeable with comparable units.

For complete Logiline system data or digital design application assistance write: Special Products Division, Sprague Electric Company, 347 Marshall Street, North Adams, Massachusetts.

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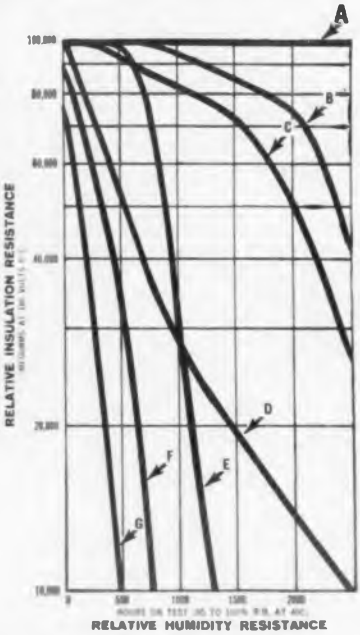

- A **DIFILM DUAL DIELECTRIC** (paper and polyester film) with **HCX®** solid impregnant and molded phenolic case
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- C **DIFILM DUAL DIELECTRIC** with solid impregnant and dipped epoxy resin coating
- D **PAPER DIELECTRIC** with wax or oil impregnant and molded phenolic case
- E **POLYESTER FILM DIELECTRIC** with molded case
- F **PAPER DIELECTRIC** with solid impregnant and waxed cardboard jacket
- G **PAPER DIELECTRIC** with wax or oil impregnant and waxed cardboard jacket

Plotted on the above graph is a curve for each of the seven basic tubular capacitor types normally used in commercial electronics. Note how Sprague Difilm® Black Beauty® tubulars (Curve A) withstand more than 2500 hours in 95 to 100% relative humidity at 40 C, *with no change in humidity resistance!*

For complete technical data on Type 160P Difilm Black Beauty Capacitors, write for Engineering Bulletin 2025 to Technical Literature Section, Sprague Electric Company, 347 Marshall Street, North Adams, Massachusetts.

CIRCLE 19 ON READER-SERVICE CARD

WASHINGTON REPORT

John Christie

HARSH CRITICISM OF THE FCC in the Landis report on federal regulatory agencies is substantiated by the commission's repeated inability to render timely, clear-cut decisions on policy questions of vital concern to the electronic industry. The two years of frustrating deliberations preceding allocation of frequencies above 890 mc to commercial microwave users is a classic example of how the FCC can hold back development of a promising market. Worse still, there are indications that the commission may yet reverse itself and permit sharing of these frequencies with space communications as requested by the common carriers.

The Landis report cited the UHF television issue, relative to which FCC experiments are just getting under way, as "a debacle" that has been "plainly apparent for some five or six years." It could just as well have cited the commission's vacillation on the question of stereophonic broadcasting.

The lag between administrative action and technological progress in space communications gives particular significance to the report's sharp criticism of the lack of policy planning and long-range programing. As industry spokesmen readily acknowledge, the commission has waited for industry to raise major policy questions instead of anticipating them with its own investigations and staff studies.

LACK OF FCC LEADERSHIP is attributed by Landis to "the quality of top personnel" as well as to unrealistic procedures. The report recommends that the commissioners delegate more of the routine to subordinates. It is recommended that quasi-judicial hearings for radio and television licenses be abandoned "in cases where they have turned out to be useless."

Landis credits the FCC staff with "considerable technical excellence." However, industry observers feel that a great deal more technical competence needs to be built into the FCC if policy planning is to be really effective. They note that the military services and NASA far surpass the regulatory agencies in quantity and quality of topflight scientific talent. But, in all fairness to the agencies, it must also be noted that Congress hasn't been as generous with the necessary funds.

Industry critics, while anxious to see the FCC's own policy-making machinery strengthened, contend that industry advisory committees could aid the FCC to a greater extent if such service did not involve the risk of an antitrust action. (This factor is credited with thwarting progress on the stereophonic-broadcasting issue.)

LOCATION OF EARTH TERMINALS is under further investigation as part of the long-range space communications studies due to be filed with the FCC by March 1. The commission seeks industry

views on what protected geographical areas might be established and held in reserve for future earth terminals for civil space communications. "If such a concept were adopted," states the commission's request, "it might be advisable to prohibit, for example, the use of certain frequency bands between 1,215 mc and 10,000 mc within 'X' miles of any given site for any use other than space communications."

The issue first came up when the EIA objected to an AT & T petition for permission to put a development earth terminal for space communications experiments atop a hill near its Holmdel, N.J. facility. EIA, noting that Holmdel was the center of high-density microwave communications, claimed the terminal should be located in a depression.

A THREE-PULSE SIDE-LOBE SUPPRESSION feature for incorporation in the FAA's air-traffic control radar-beacon system is ready for adoption as a national standard, with final action due by the end of January. The beacon system detects and identifies aircraft equipped with transponders out to a range of 200 nautical miles from ground interrogation facilities. The rotating beam of the beacon system now transmits two closely spaced pulses to interrogate. Undesirable side-lobe interference will be eliminated by transmission of a third nondirectional pulse positioned between the two interrogating pulses.

Transponder manufacturers have been preparing for the side-lobe suppression feature for about a year and a half. Modification can be achieved by adding a printed circuit to the transponder's logic circuitry. In-service transponders and those in the production process can be retrofitted. Ground interrogating and receiving stations will require the mounting of a dipole antenna adjacent to and at the same height as the directional antenna.

Except for jets, the commercial airlines have held off on equipping their planes with transponders, pending solution of the side-lobe suppression problem. Now, the market for transponders will boom. Radar-beacon systems are programed by the FAA for 171 sites and a good deal of the ground equipment is already on order. The agency has developmental systems at nine sites (four in the New York area, two in Chicago, two in Washington, D.C., and one in Norfolk, Va.). These were established under a crash program to accommodate jets when commercial jet service first began. In addition, there are 13 joint-use (FAA-military) sites in operation.

ALTITUDE REPORTING is another feature the FAA hopes to introduce into its radar-beacon systems in the near future. The aircraft transponder would be interlaced with the altimeter to supply altitude readings automatically when interrogated from the ground.

A digitizer would be used to put altimeter readings in digital form to be fed into an encoder-decoder for transmission by the transponder. Existing digitizers can be used for the purpose. The encoder-decoder can either be made part of the transponder or supplied as a separate box. FAA engineers are ready to work with manufacturers in putting the scheme into effect.

The FAA feels that altitude reporting by this means is the best interim measure available until such promising developments as a data link and electronic or frequency scanning devices meet requirements necessary for a role in air traffic control.

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CIRCLE 20 ON READER-SERVICE CARD

NEWS

AGREE Saved AF $125 Million Hoffman Tells Reliability Meeting

Air Force savings of an estimated $125 million in maintenance and supply costs on a $40 million contract through adherence to AGREE reliability requirements were cited by H. L. Hoffman, president, Hoffman Electronics Co., at the National Symposium of Reliability and Quality Control last week.

Mr. Hoffman, in delivering the keynote address at the Philadelphia conference, said the Air Force had informed him of this projected saving on 10,000 TACAN units. These units were upgraded from 17 to 150 hours mean time between failures through use of AGREE requirements.

Cites Conclusions Reached Through AGREE Experience

The following conclusions, based on his company's experience, were given by Mr. Hoffman:

- Reliability requires experience and can only be obtained through maturity of design after rugged testing and pre-production as well as production experience.
- Any manufacturer considering a contract containing AGREE requirements must critically examine his procedures and personnel. (Only one out of 20 job applicants were accepted for work on this equipment under the Hoffman program.)
- Defense Department policy on reliability specifications must be unified. At the present time, only the Air Force intends to apply AGREE procedures on a broad front.

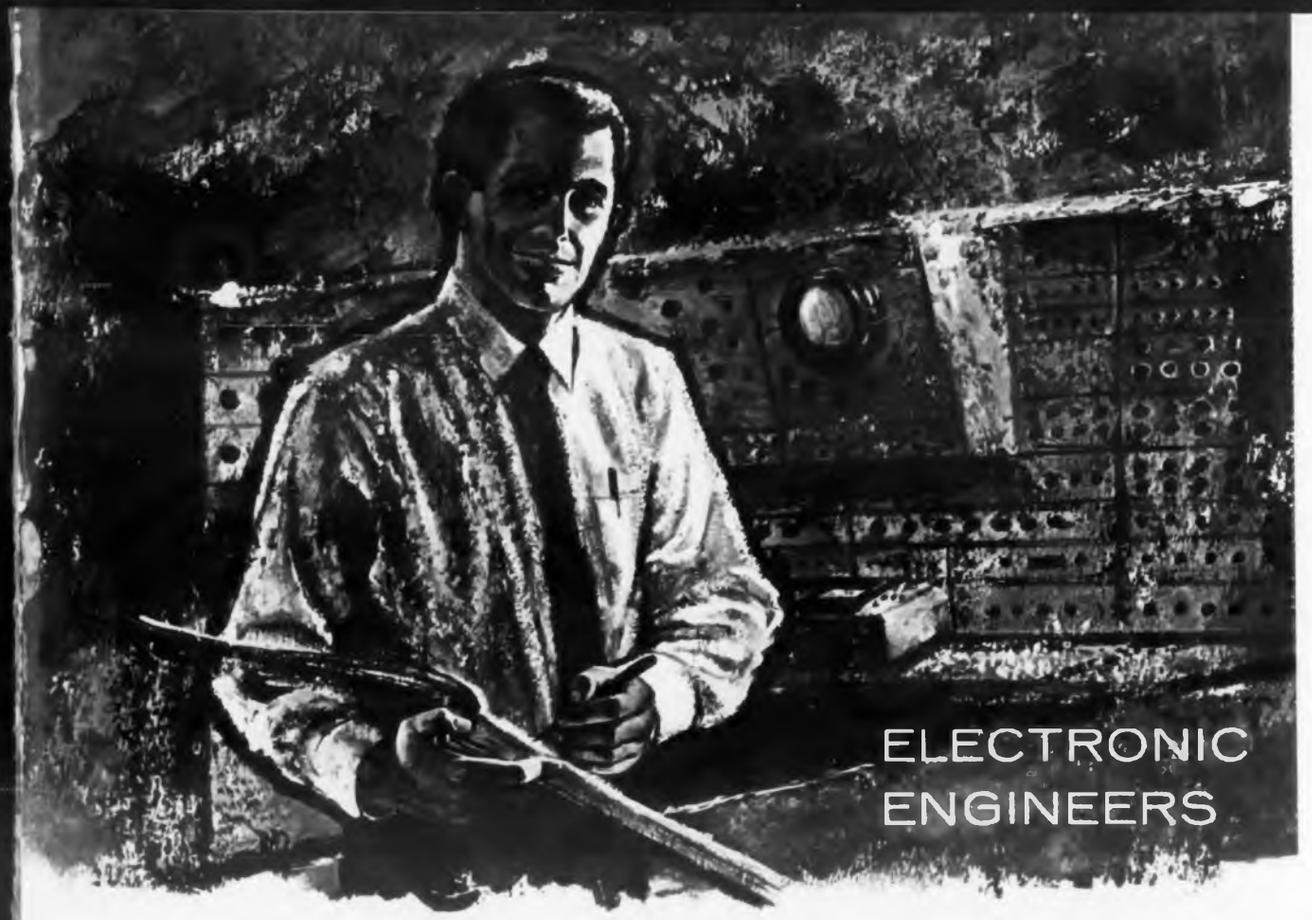
Mr. Hoffman also called for equitable contracting policies toward such factors as expensive environmental test equipment required by component suppliers and equipment manufacturers to meet AGREE reliability procedures. The extra time required for AGREE-type equipment must also be considered when delivery dates are established.

Further details of the conference will appear in the Feb. 1 issue of ELECTRONIC DESIGN.

Accuracy Is Our Policy . . .

A credit line was inadvertently left off Figs. 2 and 3 on pp 63 and 64 of the Nov. 9, 1960, issue. The photos showed welded-circuit modules which are examples of the microminiaturization program under way at Lockheed Aircraft Corp. Missiles and Space Div., Sunnyvale, Calif.

CIRCLE 901 ON CAREER INQUIRY FORM, PAGE 173 ➤



AN IMPORTANT MESSAGE TO ENGINEERS

"Tell me with whom thou art found, and I will tell thee who thou art."—Goethe (1749-1832)

These words, written more than 150 years ago, are as true today, if not truer, than they were then. To the engineer today, they emphasize the immense importance of deciding on a wise and fruitful professional association.

At Convair Astronautics, the Electronic engineer enjoys the freedom and prestige afforded men who are creating and testing the space and missile systems of the future.

Currently, Convair Astronautics needs Circuit Designers for systems design and integration of:

1) Launch control circuits. These are relay and transistorized open loop, and sequential switching circuits for the automatic control of the countdown process for the Atlas missile.

2) Test Equipment design. Switching and analogue circuitry for automatic test and checkout equipment. Assignment will be of a project nature from conception to production.

3) Tracking systems design. Communications, pulse and phase shift techniques for the design of ultra-precise missile and satellite tracking systems.

4) Telemetering design. Communications, modulation, and data sampling techniques for telemetering and data acquisition systems.

Inquiries are also invited from scientists possessing doctorate degrees and the desire to do research beyond the state of the art in communication techniques and solid state devices.

You will be associated with Convair-Astronautics, the company that designed, builds and tests this country's first intercontinental Ballistic Missile.

These positions provide stability, growth opportunity and the satisfaction of working on a program which is both highly advanced and of vital significance to the future of the free world.

You will find more information on the back of this page and a convenient, confidential Engineering Placement Inquiry. A prompt reply to your inquiry will be forthcoming from Mr. R. B. Merwin, Industrial Relations Administrator-Engineering, Dept. 130-90, Convair-Astronautics, 5585 Kearny Villa Road, San Diego, California.

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Technical openings also exist in other specialties. Write Mr. R. B. Merwin, Industrial Relations Administrator-Engineering, Dept. 130-90, Convair-Astronautics, 5585 Kearny Villa Road, San Diego, California.

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New German Milling Machine Can 'Foresee the Future'

A British tape-control system which anticipates errors is being used on a new type of German milling machine. The machine was shown for the first time at the German Machine Tool Fair at Hannover.

The German machine, a Droop and Rein FS80 vertical mill, is controlled by the EMICON system designed and manufactured by EMI Electronics, Ltd. This system incorporates a new angle safety unit, which is said to foresee any program error or irregularity in the tape. The safety unit reportedly brings the safety circuits into operation before the cutter arrives at a danger point.

Amplifying Telephone Handsets Are Developed by British Company

Amplyfying telephone handsets designed to assist people who are hard of hearing have been developed by Ericsson Telephone Ltd. of London, England. Although originally intended for use of the deaf, they can also be used by people with normal hearing in situations where reception is difficult.

The handsets are made in three patterns and each embodies a transistor amplifier built into the handle which boosts the power fed to the receiver. All three types have the same electric circuit and characteristics and draw their operating current from the same source as the instrument transmitter, so that no additional battery is required.

Each amplifier embodies a single junction transistor providing a maximum gain in excess of 20 db. This gain may be adjusted by a miniature volume control mounted either in the flat inside of the handset handle or adjacent to the receiver cap. In each case the inconspicuous control knob is conveniently manipulated by the hand in which the telephone is held without removing the handset from the ear.

A partly dismantled telephone handset fitted with transistorized amplifier unit to aid the deaf. The amplifier, developed by Ericsson Telephone Ltd., is controlled by the little wheel knob just visible in the center of the unit.

◀ CIRCLE 901 ON CAREER INQUIRY FORM, PAGE 173

NEWS

Amplification of Nerve Signals May Speed Up Muscle Responses

Muscle-response studies now in progress may lead to hardware capable of speeding up or replacing muscle functions, according to Dr. David Ellis, manager of Litton Industries' Medical Electronics and Bionics Laboratory, Woodland Hills, Calif.

In one project, Litton scientists at the Laboratory used nerve signals to drive electromechanical devices, eliminating the usual muscle response time. Nerve signals, generated by thinking about a given muscular function, were amplified and transmitted to a digital stepping motor and its related circuitry. The motor provided the mechanical action necessary, Dr. Ellis said.

The amplifier-transmitter, called a Biopack, is being modified for use in a central nursing station being developed by Litton for monitoring special-care hospital patients. (*ED*, Dec. 21, 1960, p 5). The unit contains its own power supply.

Faster Pilot Responses Among Possibilities for Concept

Quickened response time may be critical in flying high-speed aircraft, but the concept also has many other important possibilities, according to Dr. Ellis.

The conservation of human energy through use of mechanical substitutes for muscles may be an important factor in minimizing oxygen consumption during space flights, he pointed out. Similar techniques might also be developed for directing robot machines.

Prosthetic devices, such as artificial arms or legs, might also be driven with nerve signals amplified by Biopacks. These signals could be obtained from above the non-functioning or missing portion of the limb, or from the opposite side of the body. Paralyzed limbs might also be stimulated in this fashion, according to Dr. Ellis.

Biopack Can Also Monitor Athletes and Astronauts

The Litton Biopack is already being applied in many other studies. These include dynamic electrocardiograph monitoring of athletes, monitoring the cardiac rate of active longshoremen, basic research in psychology and psychophysiology, manned-astroflight simulation studies in a human centrifuge, index-of-work studies, animal physiology, human dentition studies, and sensing and transmitting animal motion.

The unit will also be used for monitoring the physiological effects of space flight on the astronauts, according to Dr. Ellis.

2-Dimensional Tracer System Aids Shaping of Porcelain Insulators

Complete automation of turning operations in the production of porcelain insulators has been accomplished with the application of a two-dimensional tracer system.

A prototype machine, complete with controls, has been developed by Seneca Falls Machine Co. of Seneca Falls, N.Y., but the control system can readily be applied to existing equipment.

The system is electromechanically controlled and will follow any contour around a 360-deg path at a constant cutting speed—regardless of direction. The value of the cutting speed can be varied manually, or can be automatically controlled as a function of spindle speed to maintain a constant feed rate in inches per revolution of the spindle.

The two-dimensional tracer system incorporates a rotating eccentric stylus design. All critical assemblies are eliminated and the need for adjustment is minimal. The stylus assembly on contact with the template, which conforms with the contours to be cut into the porcelain insulator, continuously feeds signals to X and Y axis servo drives. These low-powered signals are boosted to actuate a servo motor, which controls table and cutting movement for any value of the X and Y coordinates.

Tiny Tunnel Diodes from IBM

Two new germanium diodes, one a low-peak current type for fast switching and the other for storage, are being packaged by International Business Machines Corp. in these cases, shown next to a match head. Above is a "micro-wedge" design and below is a "rivet" type. Flow of an etching fluid through a hole in the diodes' ceramic bodies, shown for the rivet type, is servo-controlled to give peak currents within 1 per cent tolerance. The switching diode has a 5-ma peak current and a resistive cut-off frequency of 23 Gc. The storage diode has current capacity of 35,000 amp/cm².

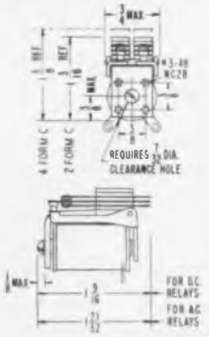
COMPACT, RELIABLE, VERSATILE . . .
this is P&B's miniature MH relay

The MH is not a new relay.

As a matter of fact, we've been building and selling this series for seven or eight years. Its reliability and exceptional longevity have been proved in business machines, airborne computers and a host of other products.

Engineers like its fast action, its small size, its light weight. They like the wide selection of contact forms . . . up to 18 springs (9 per stack, DC) as well as the fact MH relays can be furnished to switch loads ranging from dry circuit to over 5 amps at 115 volts, 60 cycle resistive.

A multiple choice of terminations add to the MH's versatility. This relay, for example, can be adapted for printed circuits, furnished with taper tabs or a long list of other terminals. Get all the facts by calling your nearest P&B sales engineer today.



MH ENGINEERING DATA

GENERAL:

Breakdown Voltage: 500 volts RMS between all elements.

Ambient Temperatures: −45° C to +85° C. (−65° C to +125° C on special order.)

Shock: 30g on special order.

Vibration: 10g from 55 to 500 cps.; .065" max. excursions from 10 to 55 cps. on special order.

Weight: 2⅓ ozs. max. (open relay)

Terminals: Pierced solder lugs, special lugs for printed circuits, taper tab (AMP #78).

CONTACTS:

Arrangements: Up to 9 springs per stack.

Material: ⅛" silver standard. Palladium or gold alloy also available.

Load: Dry circuits to 5 amps @ 115V AC res.

COILS:

Resistance: 22,000 ohms max.

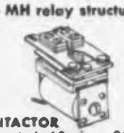
Power: 100 mw per movable min. to 4 watts at 25° C max (200 mw min. to meet max. shock/vibration spec.)

Duty: DC: Continuous. AC: Intermittent (Two pole relay max.) open. Sealed units supplied with full wave rectifier inside can.

Voltages: DC: Up to 110 volts. AC: Up to 230 volts 60 cycles.

The relays below are variations of the MH relay structure.

MA LATCHING
Electrical latch, mechanical reset. Small, versatile and offered with selection of contact arrangements.



MB CONTACTOR
Contacts rated 60 amp, 28 volts DC non-inductive. Will carry 150 amp. surge for a duration of 0.3 seconds.

MH SEAL-TEMP
Features sealed coil to minimize contact contamination. Available as hermetically sealed relay only.

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EDITORIAL

Don't Trust the Design Engineer

"Just assume that the designer didn't know what he was doing" is the alarming and damning advice of a systems engineer testing out the missiles that are suppose to get us to the moon and back.

The philosophy is apparently paying off in speeding up the time in getting to a countdown and in reducing the number of countdowns needed to get a successful launch. Because of the assumption that the equipment received from the design engineer won't work, exhaustive tests are made and considerable data are gathered on a methodical basis. This makes it possible to perform remedial engineering on the spot. As a result, the U.S. manages to keep to some semblance of a firing schedule.

The checkout engineers at the launch site assume that impedance match between units to be interconnected is way off. So they measure impedance. In like manner, they assume permissible voltage and frequency variations will go out of tolerance and they measure these values carefully. In short, they assume the engineer really didn't know what he was building.

Since modifications and tuning up are hard to perform in a compact trailer designed to accommodate only perfected equipment and operating personnel, it is easy to see why small regard is held for the designer who didn't know what he was doing.

Can engineering be returned from a trailer on the launch site back to the lab where it rightfully belongs? We think so, but it will require considerably more awareness on the part of the designer regarding the ultimate use of his product. Never can he ignore operating environment, which is so hard to visualize in the lab. Foremost is the need to realize that no one piece of equipment is in a field or class of its own. There is no such thing as an isolated piece of equipment. Every component, every subassembly, every equipment is part of a system. And they are all parts of a system intended to fulfill no less than the requirements demanded by our national goals.

James A. Ryder

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Tunnel-Diode Performance in an Oscillator Circuit

If a tunnel diode circuit is tuned to the point of free sine-wave oscillation, its electrical parameters can be expressed by a simple mathematical relationship. Hans Dill explains how oscillator jigs can be constructed to permit rapid measurement of lead inductance, junction capacitance, dissipative resistance and resistive cut-off frequency.

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RAPID production testing or precise laboratory measurements on tunnel diode parameters can be performed with the device connected to an oscillator jig. With the negative conductance and capacitance of the diode known, the resistive cut-off frequency and dissipative resistance can be calculated. If negative conductance and dissipative resistance are given, capacitance and lead inductance can be found.

Equivalent Circuit Of an Ideal Tunnel Diode

The equivalent circuit of an ideal tunnel diode consists of a negative conductance, g_t, and a junction capacitance, C_t, in parallel as shown in Fig. 1; g_t, should remain constant with frequency over an extremely wide range. In practice, the performance of a tunnel diode is limited in the following manner:

(a) The negative conductance appears only in a certain bias region and varies with the bias potential across the diode. Thus, special biasing arrangements must be used to achieve a stable operating point with the desired negative conductance.

(b) The dissipative resistance R_s and the lead inductance L_s limit the frequency response and stability of the tunnel-diode circuit.

The equivalent circuit of a tunnel diode in Fig. 1 can also be used to represent a series-oscillator or amplifier circuit if it is assumed that R_s is the sum of all dissipative resistances in the circuit and L_s is the sum of all series inductances.

The impedance, Z, of a tunnel diode, consisting of a real and an imaginary part, is derived from the equivalent circuit in Fig. 1.

$$Z = R_s + j\omega L_s + \frac{1}{j\omega C_t - g_t}$$

$$Z = \underbrace{R_s - \frac{g_t}{g_t^2 + \omega^2 C_t^2}}_{\text{real part}} + \underbrace{j\omega\left[L_s - \frac{C_t}{g_t^2 + \omega^2 C_t^2}\right]}_{\text{imaginary part}}$$

Two critical frequencies are found for $Z = 0$. The resistive cut-off frequency ω_R is the frequency at which the real part of Z disappears.

$$\omega_R = \frac{g_t}{C_t}\sqrt{\frac{1}{R_s g_t} - 1}$$

The resonance frequency ω_x is by definition located where the imaginary part of Z is zero.

$$\omega_x = \frac{1}{C_t}\sqrt{\frac{C_t}{L_s} - g_t^2}$$

The stability of a tunnel diode circuit depends on the value of ω_x and ω_R:

$\omega_x > \omega_R$ $Z = +R$
The circuit is stable because the real part of Z is positive.

$\omega_x = \omega_R$ $Z = 0$
Only in this condition free sine wave oscillations are possible. Linear circuit analysis can be applied.

$\omega_x < \omega_R$ $Z = -R$
The circuit is unstable because the real part of Z is negative. Nonlinear oscillations may occur over the entire negative resistance region. Fig. 2 indicates the different modes of operation.

Stable operation is possible for the following value of R_s

$$\frac{1}{g_t} > R_s > \frac{L_s g_t}{C_t}$$

The area of stable operation exists only as long as ω_x is a real solution; it disappears as soon as ω_x becomes imaginary. The different conditions are shown in Fig. 3. This leads to the conclusion that free sine-wave mode is only possible as long as

$$L_s < L_{smax} \qquad L_{smax} = \frac{C_t}{g_t^2}$$

Tunnel Diode Oscillator Circuit Details Resistance, Inductance Components

The tunnel diode oscillator circuit in Fig. 4, showing all the resistance and inductance components in detail, can be reduced to the same series circuit as shown in Fig. 1. If the circuit is tuned so that $\omega_x = \omega_R$, the following basic relations are obtained:

$$R_s = \frac{g_t}{g_t^2 + \omega_R^2 C_t^2}$$

$$\omega_R = \frac{g_t}{C_t}\sqrt{\frac{1}{R_s g_t} - 1}$$

g_t negative diode conductance
C_t junction capacitance
R_s dissipative resistance
ω_R resistive cut-off frequency

The resonance frequency ω_x closely approaching the cut-off frequency ω_R can be measured with a tunable vhf receiver. The expression for the resistive cut-off frequency permits the calculation of any one of the three parameters g_t, C_t and R_s if the other two are given. As shown in Fig. 5, f_R is tabulated as a function of C_t, g_t and R_s. The highest circuit inductance L_{smax} for possible free sine-wave mode is also given.

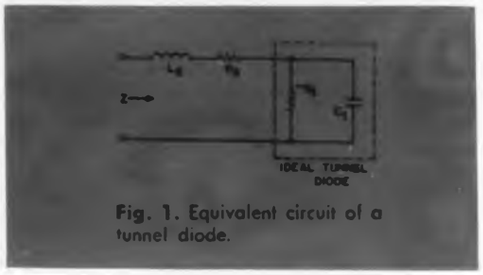


Fig. 1. Equivalent circuit of a tunnel diode.

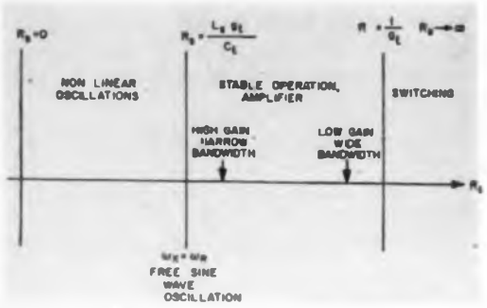


Fig. 2. Possible modes of operation with a tunnel diode.

The tunnel diode oscillator in Fig. 4 consists mainly of a variable inductance L_{sm}. The loss resistance R_{sm} of that inductance can be calculated from the circuit Q.

$$R_{sm} = \frac{\omega L_{sm}}{Q}$$

The resistor R_{sp} provides the dc bias for the tunnel diode.

Some diodes have a relatively high lead inductance L_{st}. In this case, it is possible that the highest self-resonant frequency ω_x of the circuit is lower than the resistive cut-off frequency ω_R. To achieve free sine wave mode in such a case, ω_R is lowered by insertion of an additional damping resistor, R_{sz}. The size of R_{sz} is given by the following equation:

$$\omega_{X\,max} > \omega_{Rz}$$

where ω_{Rz} is the resistive cut-off frequency with the damping resistor.

$$\omega_{Rz} = \frac{g_t}{C_t}\sqrt{\frac{1}{[R_{st} + R_{sp} + R_{sm} + R_{sz}]\, g_t} - 1}$$

$$\omega_{X\,max} = \frac{1}{C_t}\sqrt{\frac{C_t}{L_{st} + L_{sm\,min}} - g_t^2}$$

Parameter Measurement Can Be Performed

Depending on the known diode parameter, the following measurements can be performed:

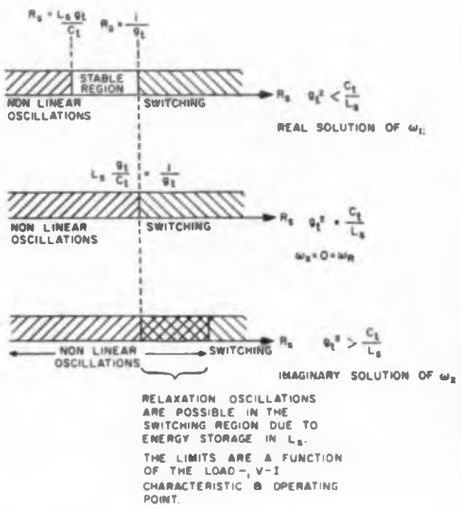


Fig. 3. Stability considerations with a tunnel-diode circuit.

(a) Resistive cut-off frequency ω_R

ω_R can be calculated from ω_{Rz} if R_{std}, g_t and R_s are known.

$$\omega_R = \omega_{Rz}\sqrt{\frac{\dfrac{1}{R_{std}\, g_t} - 1}{\dfrac{1}{R_s\, g_t} - 1}}$$

where:

ω_{Rz} is the actual cut-off frequency of the oscillator. The resonance frequency ω_X, set as close as possible to ω_{Rz}, is measured with a vhf detector. Due to the low amplitude of ω_X in this region, y_t can be assumed to be linear. g_t is taken from the V-I diagram at a chosen dc bias point.

$$R_s = R_{std} + R_{sp} + R_{sm} + R_{sz}$$

R_{std} Incremental resistance of a highly reverse biased tunnel diode. It is about equal to the dissipative resistance of the tunnel diode.
R_{sp} Source resistance of the dc bias supply.
R_{sm} Dissipative resistance of variable inductance L_{sm}.
R_{sz} Additional damping resistor.

The following circuit parameters will be referred to later:

C_{tM} Tunnel-diode capacitance measured with an admittance bridge.
C_t Tunnel-diode capacitance calculated from the cut-off frequency measurement.

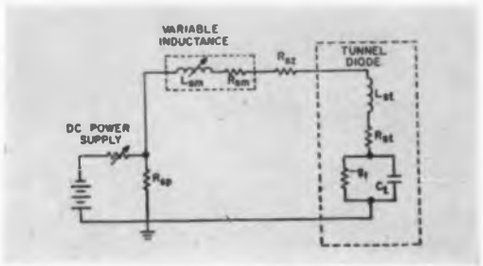


Fig. 4. Circuit diagram of a tunnel-diode oscillator. R_{SZ} represents the damping resistor required to lower the resistive cut-off frequency when ω_R is greater than ω_X. $R_S = R_{ST} + R_{SP} + R_{SM} + R_{SZ}$; $L_S = L_{SM} + L_{ST}$.

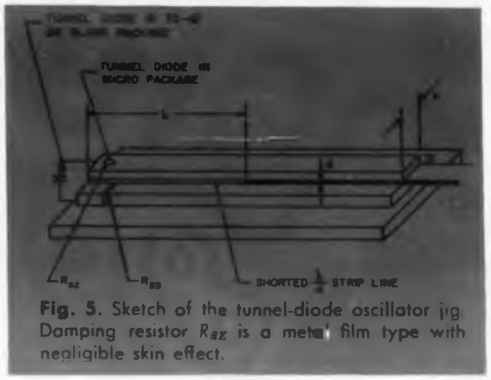


Fig. 5. Sketch of the tunnel-diode oscillator jig. Damping resistor R_{SZ} is a metal film type with negligible skin effect.

L_{st} Lead inductance of the diode.
L_{sm} Variable inductance.
R_{st} Dissipative resistance of the tunnel diode calculated from the cut-off frequency measurement.

(b) Dissipative resistance R_{st} of the tunnel diode

If, in addition to the negative conductance g_t, the capacitance C_{tM} is known, the dissipative resistance R_{st} can be found.

$$R_{st} = \underbrace{\frac{g_t}{g_t^2 + \omega_{Rz}^2\, C_{tM}^2}}_{p} - \underbrace{[R_{sz} + R_{sp} + R_{sm}]}_{q}$$

The value of R_{st} is in the region of 1 ohm or less. Computed as the difference between p and q, inaccurate results can be obtained if the amplitude of p and q is considerably larger than R_{st}. This means that the experiment works only with diodes which need a small (or no) damping resistor R_{sm}. Diodes in a low inductance micropackage, using no damping resistor, can be measured most accurately.

(c) Tunnel diode capacitance C_t

With g_t, R_s, ω_{Rz} known, the junction capacitance C_T can be calculated.

$$C_t = \frac{g_t}{\omega_{Rz}}\sqrt{\frac{1}{R_s\, g_t} - 1}$$

This method provides a fast and accurate

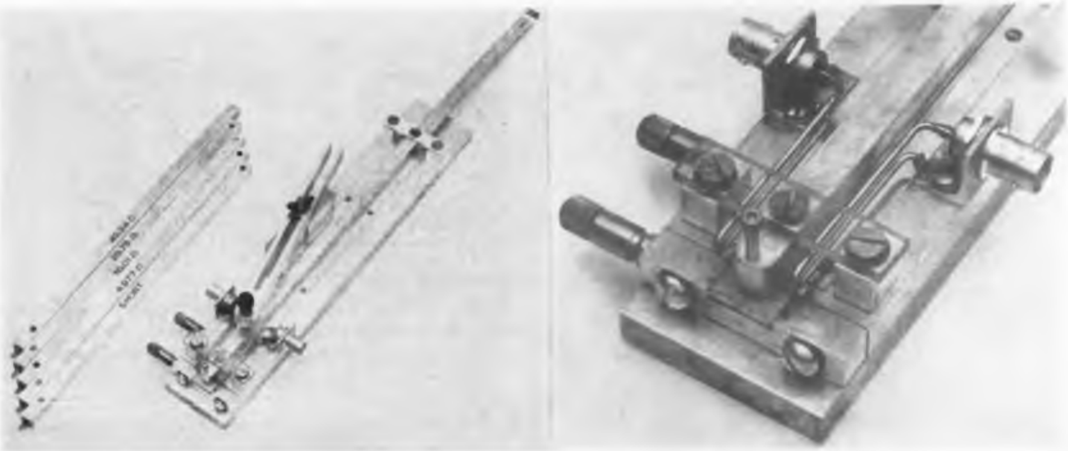
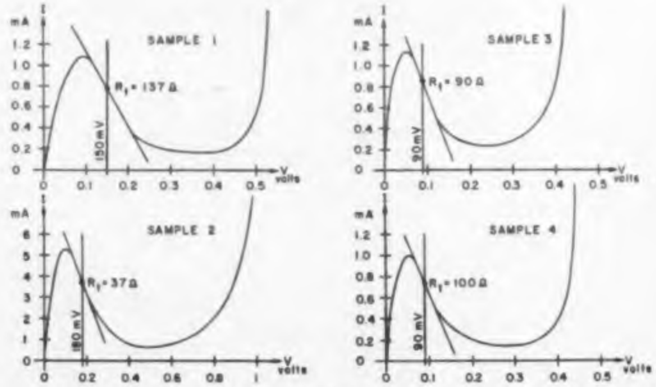


Fig. 6. Tunnel diode oscillator jig (left) with closeup (right) of mounting for micro-package (threaded screw).



	GENERAL DATA									TEST WITH OSCILLATOR JIG					DATA CALCULATED FROM OSCILLATOR TEST			
SAMPLE	MAKE	MAT'L	PACKAGE	$-g_1$ $\frac{1}{\Omega}10^{-3}$	C_{1M} pF	R_{std} Ω	L_{stM} nH	f_{R1} MC	f_{X1} MC	f_{R2} MC	λ_{R2} CM	l_{R2} CM	R_{s2} Ω	$R_{sp}+R_{sm}$ Ω	f_{R2} MC	C_1 pF	R_{st} Ω	L_{st} nH
1	GE IN2940	Ge	TO 18	7.3	5.5	1.5	5	2010	940	455	66	10.5	25.8	0.5	2180	5.2	–	15
2	TI IN652	GeAs	TO 18	27	43	0.4	5	960	330	170	177	9	10	0.3	1030	40	–	14
3	HUGHES	Ge	TO 18	11.1	31	0.4	5	860	400	250	120	9	5	0.3	960	28	–	12
4	HUGHES	Ge	MICRO PACKAGE	10	26	0.4	0.25	970	2000	900	333	3	0	0.1	1000	25	0.35	0.22

$$f_{R2} = f_{R1}\sqrt{\frac{\frac{1}{R_{std}\,g_1} - 1}{\frac{1}{R_s\,g_1} - 1}}$$

$$R_{st} = \frac{g_1}{g_1^2 + [2\pi f_{R2} C_1]^2} - R_{s2} + R_{sm} + R_{sp}$$

$$C_1 = \frac{g_1}{2\pi f_{R2}}\sqrt{\frac{1}{R_s\,g_1} - 1}$$

$$L_{st} = \frac{C_{1M} R_s}{g_1} - L_{sm}$$

$$f_{R1} = \frac{g_1}{2\pi C_{1M}}\sqrt{\frac{1}{g_1 R_{std}} - 1}$$

$$f_{X1} = \frac{1}{2\pi C_{1M}}\sqrt{\frac{C_{1M}}{L_{stM}} - g_1^2}$$

$$R_s = R_{std} + R_{s2} + R_{sm} + R_{sp}$$

$$L_{sm} = \frac{Z_0 \operatorname{tg} 2\pi \frac{l}{\lambda}}{2\pi f_{R2}}$$

b

Fig. 7. (a) Characteristics of four tunnel diodes used in test. (b) Results obtained with the ω_r-oscillator jig; parameter relationships are included.

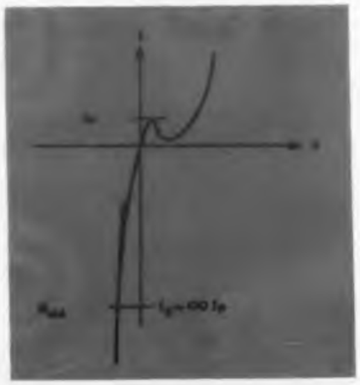


Fig. 8. Low frequency measurement of the base spreading resistance R_{BTD}.

measurement of the tunnel-diode capacitance in the negative resistance region.

(d) Inductance L_{st} of the tunnel diode

L_{st} can be calculated from the following relation which holds at the point of free sine wave oscillation.

$$R_s = \frac{[L_{st} + L_{sm}]\, g_1}{C_1}$$

$$L_{st} = \frac{C_1 R_s}{g_1} - L_{sm}$$

Construction of the Oscillator Jig Is Also Shown

The diagram and a simplified drawing of the oscillator jig are shown in Figs. 4 and 5. The inductance L_{sm} is produced by a shorted strip line of variable length. In general, the impedance of a $\lambda/4$ strip line is given by:

$$Z_x = Z_o \frac{R_2 \cos 2\pi \frac{l}{\lambda} + Z_o j \sin 2\pi \frac{l}{\lambda}}{Z \cos 2\pi \frac{l}{\lambda} + R_2 j \sin 2\pi \frac{l}{\lambda}}$$

For the shorted strip line ($R_2 = 0$)

$$Z_x = Z_o j \tan 2\pi \frac{l}{\lambda}$$

Resonance occurs at $l = \lambda/4$ only if the line is not loaded at the input.

Load at the input	Resonance	
Open	$l = \frac{\lambda}{4}$	$Z = 0$
Capacitance	$l < \frac{\lambda}{4}$	line behaves like a lumped inductance
Inductive	$l > \frac{\lambda}{4}$	line behaves like a lumped capacitance

$$L = \frac{Z_o t_g \frac{2\pi l}{\lambda}}{\omega}$$

$$C = \frac{1}{\omega Z_o t_g \frac{2\pi l}{\lambda}}$$

A tunnel diode appears capacitive, in general; therefore the strip line resonates at $l < \lambda/4$.

The impedance Z_o of the strip line has been chosen to match most tunnel diodes in the frequency range from 500 to 1,500 mc. It can be adjusted from 10 to 25 ohms by varying the distance d of the strip line.

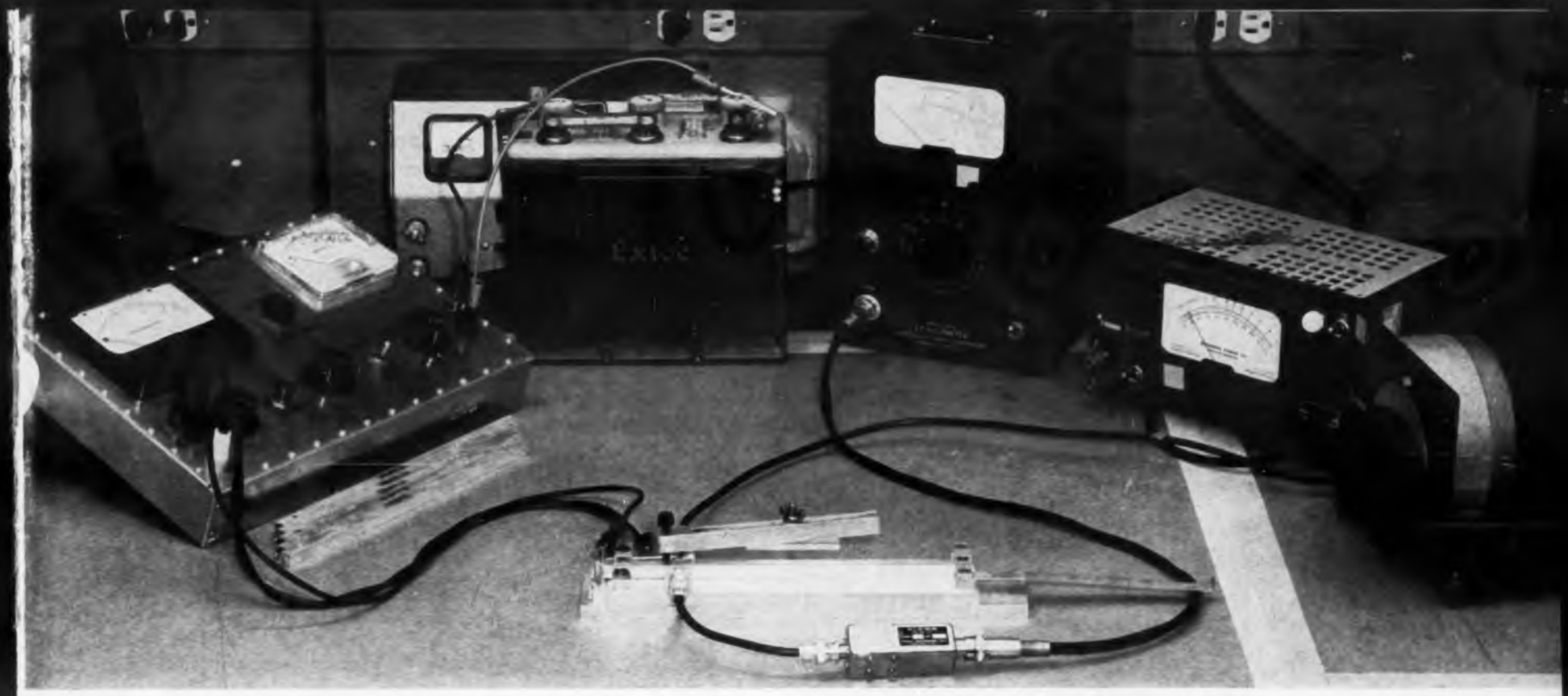


Fig. 9. The complete measurement set-up is useful up to 9 kmc.

The resistor R_{sp}, built into the end of the top strip line bar, is a metal film type resistor with negligible skin effect and very low capacitance. The power supply resistor consists of a thin bar of germanium to keep the skin effect small. It is mounted so that it does not affect the operation of the jig. The dc value of R_{sp} is about 0.03 ohm. The power dissipation in the biasing resistor is no problem for currents up to 10 amp because the germanium bar is soldered between brass which acts as an infinite heat sink. The loss resistance R_{sm} of the microstrip is calculated from the measured circuit Q. Photographs of the oscillator jig are shown in Figs. 6a and 6b.

Measurement Technique and Data For Four Different Diode Types

Four different types of diodes have been tested; the general parameters and test results are shown in Figs. 7a and 7b.

The junction capacitance C_{tM} has been measured in the valley region with the Wayne-Kerr bridge, type 801. The dissipative resistance R_{std} is approximately equal to the slope dV/dI of a highly reverse biased diode as shown in Fig. 8.

The actual measurements are simple to perform. They consist of the following steps:

1) Mount diode.
2) Adjust dc bias according to the *V-I* diagram.
3) Reduce inductance L_{sm} until the oscillations stop. If the lead inductance L_{st} of tested tunnel diode is high, oscillations may occur even if $L_{sm} = 0$. In this case, a higher damping resistor R_{sm} must be selected. (A Boonton rf voltmeter was used as an indicator in the tests with the pick-up probe very loosely coupled.)
4) Measure the frequency just before the oscillations disappear. A tunable vhf detector of high sensitivity is necessary. (General Radio oscillators, mixer and 30-mc if amplifiers gave good results.)
5) Measure L and Q of the jig.

Fig. 9 shows the complete measuring arrangement.

The measured values and the computed results are tabulated in Fig. 7.

The most important step necessary to achieve accurate results is to measure ω_X as closely as possible to $\omega_{R=}$. The theoretical limit $\omega_X = \omega_{R=}$ could only be reached with an infinite sensitive receiver using a probe which does not load the oscillator. In practice it appears possible to measure ω_X within five per cent of $\omega_{R=}$.

The resistance cut-off frequency is easy to calculate. The results indicate that the dissipative resistance of the diode R_{std} measured in the audio range agrees fairly well with the R_{st} in the lower microwave region. The junction capacitance is measured directly in the negative resistance region where the circuits normally operate. The dissipative resistance R_{st} could only be measured with the micro-package. The results with the TO-18 package were too inaccurate because of the error introduced by the additional damping resistor.

The inductance of the samples with TO-18 package depends on the mounting arrangement. In case of the micro-package, the measurement is more accurate and simpler to perform than with bridges.

The results obtained are very accurate if one takes in account that the capacitance C_{tM} measured with the Wayne-Kerr bridge is considerably higher than the capacitance C_t in the negative resistance region. ■ ■

Acknowledgment

The author wishes to thank Mr. M. R. MacPherson for the experimental work carried out and many useful suggestions.

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Five-Binary Counting Technique Makes Faster Decimal-Counting Units

Zoltan Tarczy-Hornoch developed the novel counting circuit described here in Hungary just before the 1956 revolution which forced him to leave that country. Last year he made a full patent disclosure on the circuit. The first products based on the circuit were shown at the recent WESCON show in Los Angeles.

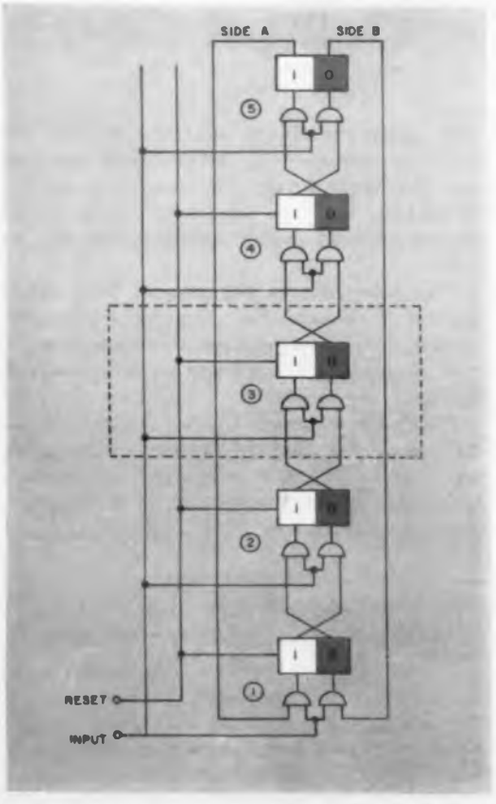

Fig. 1. Five-binary decimal counter with binaries in reset condition, side *A* conducting. Gates are held open by 0. Input pulse through an open gate can switch a binary only from 0 to *1*. Schematic of area enclosed by dashed line is shown in Fig. 3.

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THOUGH the speed requirements for decimal-counting units have increased sharply in the past few years, most efforts to meet these demands have taken the form of merely pushing conventional decimal-counting schemes[1,2] which haven't changed for years. Most engineers have relied largely on using better components, faster transistors, higher currents, and lower impedances with variations of the conventional scale-of-sixteen binary counter with feedback or the ring counter.

Binary Resolution Limits Conventional Counters

The basic speed limitation of the four-binary scheme is this: it cannot count faster—either continuously or on double pulse—than the first binary in the chain. The feedback or gating usually presents an additional limitation on the maximum counting rate.

In the ring counter, the counting speed of the individual binaries is not high, but the double-pulse resolution is still critical. For two successive pulses, each binary must be able to turn on and off. The fact that for every input pulse two switching actions occur simultaneously presents timing problems. The decimal ring has an additional drawback in requiring 10 bistable stages—a rather wasteful use of binaries.

A newer technique* is available that overcomes the basic speed limitation of both four-binary counters and decimal-ring counters.

*Patents pending.

Faster, Simpler Technique Uses Five Binaries

The new decimal-counting technique, first announced in *ED*, Oct. 12, 1960, p 58, uses five binaries to provide a count of 10. Each binary is turned on in succession until all are on. Each is then turned off in the same order. This system provides a unique advantage: each binary counts at the same speed (one-fifth of the input count rate), and at exactly 50 per cent duty cycle—most advantageous for fast binary operation.

Furthermore, the double-pulse resolution is not limited by the resolution of any one stage since no stage would switch twice in succession. Since only one switching action takes place at one time, this improves speed and eliminates critical timing problems.

Fig. 1 shows a block diagram of the new counting logic. In the reset condition, as shown, all binaries are off and side *A* conducts. The *AND* gates pass an input pulse only if the input is connected to the *O* side of a binary. If the input signal gets through the gate, it can only turn a binary on from *0* to *1*. If it is already on, no switching occurs.

Since the gates are held open by *O*, gates *1B*, *2A*, *3A*, *4A*, and *5A* will pass the input pulse. But the last four gates feed the pulse into the *1* side of the binaries, so only gate *1B* can act. Hence the first binary turns on and side *B* switches from *0* to *1*. In this state, gates *1B*, *2B*, *3A*, *4A*,

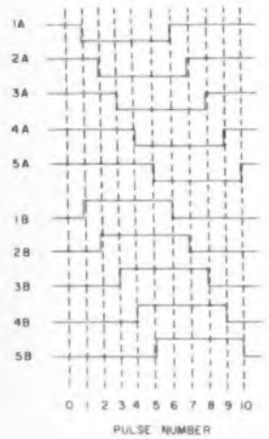

Fig. 2. Idealized output of binaries in Fig. 1 for 10 input pulses. Reset condition is indicated by 0. One binary switches at a time at 1/5 the input frequency.

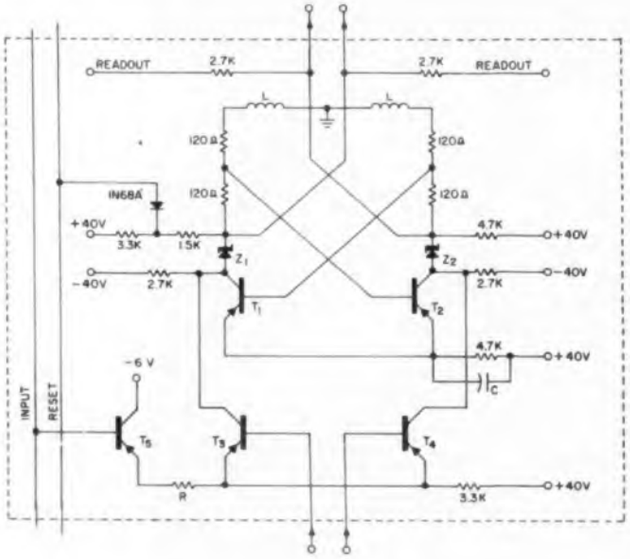

Fig. 3. Circuit of enclosed area of Fig. 1. *T1* and *T2* form a current-mode binary. *T3* and *T4*, with the *T5* emitter follower, serve as a current-switching steering gate. Both input and reset are positive pulses. In quiescent condition, one binary transistor and *T5* are conducting. Transistors are 2N1143. Zener diodes are 1/4 M6.8Z10.

and 5*A* are open for the second pulse.

The second pulse can turn in the second binary. The third pulse turns on the next binary and this sequence continues till all binaries are on after the fifth pulse. This condition is the exact opposite of the reset state since, in all stages, side *B* conducts instead of side *A*.

With succeeding counts, each stage switches in the same sequence but to the opposite side. The sixth pulse turns off the first binary, the seventh turns off the next, and finally, after the tenth pulse, all binaries are off again. Fig. 2 shows the idealized output waveforms of the binaries, illustrating the switching sequence.

All Binaries Operate At One-Fifth Input Count Rate

Since the binaries operate at one-fifth the input counting rate, the maximum speed is limited primarily by rise time rather than by recovery time of the binary stages. As an example, a 30-nsec, double-pulse-resolution binary with otherwise good rise time cannot be built into better than 30-mc, conventional, decimal-counting units. Even that frequency is doubtful because of feedback and gating problems.

But the same binaries can count at 150 mc in the new counting scheme. Fig. 3 shows one stage of a decimal-counting unit for operation faster than 100 mc. The current-switching principle[3] is used for both the binary (*T1* and *T2*) and for the dual gate (*T3*, *T4*, *T5*).

Current Switching Gives Speed As Well As Other Circuit Advantages

Current switching allows maximum use of the transistor's alpha cut-off frequency; it provides nonsaturating operation to avoid storage-time delays; and it uses low voltage swings to reduce the effect of capacitance. In addition, it gives excellent dc stability, transistor interchangeability, and insensitivity to temperature variations.

After reset by a positive pulse, *T1* conducts (collector high). *T2* does not (collector low). *Z1* and *Z2*, 6.8-v current-fed Zener diodes, serve as collector power supplies, translating the collector

voltage swing to 1-v change around ground potential.

Half that voltage is used for internal binary feedback to the opposite base. The full swing provides the readout and the dc-coupled control to the next gate. If the previous binary is in the same reset state, it sets the base of *T3* at −1 v and the base of *T4* at +1 v.

In quiescent conditions, both *T3* and *T4* are cut off because the base of *T5* is biased at about −1.5 v through the dc-coupled input line. *T5*, as an emitter follower, keeps the common emitters of *T3* and *T4* beyond their cut-off point. The situation changes when a positive input pulse of 1 to 2 v arrives. As *T5* follows the input pulse, there is a point where it cuts off and transfers its current to one of the other transistors, whichever has the lower base voltage (*T3* in this case).

Consequently, *T3* conducts for the duration of the pulse, and tries to turn on the already on *T1*. More precisely, it gives an extra turn-off spike to the already off *T2* through the internal feedback. This situation prevails until the previous binary changes state and reverses bias on *T3* and *T4*.

The next, and only the next pulse turns *T4* on; it gives a positive cut-off pulse to *T1*, which in turn causes *T2* to conduct and to complete the switching of the stage.

DC Coupling Avoids Base Shift, Eliminates Coupling Problems

Only dc coupling is used so there is no "baseline shift" and no critical time constants. There are an *L*, *C*, and *R* indicated, but their values are not very critical except at the highest counting rates. Even then, the values are determined mostly by the circuit layout.

There is only one adjustment possible in the circuit—the input dc bias. This bias determines the input sensitivity of the counting unit. With proper adjustment, about 1 v is the minimum input amplitude and several times that level can still be tolerated.

The best input-pulse shape is a square pulse, about 4 to 10-nsec wide. But because square pulses with 100-mc repetition rates are not easily obtained, most of the measurements can be made with a sine-wave input. To be sure that the circuit is counting correctly and not simply frequency dividing, one may apply input bursts (controlled numbers of sine-wave cycles).

Many Variations Available For Slower and Faster Operation

The circuit shown in Fig. 3 is an example only. It has many variations. For lower speed and lower cost, one can reduce the number of transistors and Zeners. Instead of current switching, one can use conventional *RC*-coupled binaries and diode gating can be used instead of transis-

tor gating. Even at lower speeds, the new logic has significant advantages.

To extend the speed range upward, one can, of course, use higher performance transistors. But there are other possibilities too. Since the double-pulse resolution of the logic depends essentially on the triggering speed and rise time and does not depend on the recovery time of the binaries, one can trade recovery for rise time. Hence, the binaries can be quite heavily overcompensated.

Since a binary receives several triggering attempts at its wrong side before it is triggered at its correct side, one can use additional gating to eliminate the unwanted triggers. Removing these disturbing transients before switching improves the sensitivity and speeds up the triggering response.

If the double-pulse resolution is improved to the point where the continuous counting speed of the binary is the limiting factor, the number of binaries can be increased. Using 10 binaries and two equidistant outputs, one can still preserve the decimal-counting feature.

Though the circuit shown uses pnp transistors, one can use npn's, combinations of pnp's and npn's, or vacuum tubes. Inherently bistable devices like four-layer diodes and tunnel diodes can also be used. For example, a known tunnel-diode decade counter[4] uses ten diodes in series. The new logic would take only five tunnel-diodes, turn them on in succession until all are on, then turn them off in the same order.

New Logic Offers Easy Readout and Preset

An additional feature of the new logic is that, by counting in straight decimal fashion, it does not require the usual binary-to-decimal code conversion. Simple resistive mixing of subsequent binary outputs automatically provides a ten-line code. This makes readout and printout particularly easy. By using diodes instead of resistors, one can construct an unusually high-speed, preset counter. ■ ■

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Acknowledgment

The author wishes to acknowledge the cooperation of Joe R. Simpson, an engineer at Eldorado Electronics, whose devoted help during the circuit development and evaluation was very valuable.

Designing Optimum Transistor Switching Circuits

Equations for rise- and fall-time calculations involving transistor switching circuits are complex and thus often ignored. Charles Askanas has prepared nomographs to simplify the work involved. These can help a designer to rapidly optimize a switching circuit in terms of performance and cost.

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TO OBTAIN faster switching time, design engineers have often resorted to expensive, high-frequency transistors. Some of the subtleties involved in order to obtain the same performance by using less expensive types have been surrounded by seemingly unwieldy transient response equations. By algebraic manipulation, these equations have been simplified and converted to nomographs to facilitate optimum switching circuit design.

To determine the collector current (i_c) response to a current step function at the transistor input, consider the approximate common base, short-circuit output, equivalent circuit shown in Fig. 1.

Charles Askanas is shown checking transistor switching speed on Lumatron's Automatic Switching Time Test Set.

For convenience, a subsidiary RC circuit is introduced, as shown in Fig. 2, to simulate the current gain attenuation as a function of frequency. The circuit equation is

$$R + \frac{1}{j\omega C} \qquad (1)$$

(This approximation neglects second order effects which partially account for the turn-on delay time. The delay time is also a function of the circuit conditions. Since its treatment is quite detailed and not pertinent, it is omitted.)

The gain decreases to 0.707 (3 db) of its low-frequency value when $R = 1/\omega_\alpha C$.

$\omega_\alpha = 1/RC$(1) and is the angular frequency at which the common base-current gain (α_{of}) decreases to 3 db from its dc value.

The response to the input current step function is given as

$$i_c = -\alpha_{of} I\,(1-e^{-t/RC}) = -\alpha_{of} I\,(1-e^{-t\omega_\alpha}) \qquad (2)$$

The time required for i_c to reach 0.1 of its final value is $0.1/\omega_\alpha$ and the time required for the transistor to reach 0.9 of its final value is $2.3/\omega_\alpha$.

$$t_r\ (\text{risetime}) = \frac{2.3}{\omega_\alpha} - \frac{0.1}{\omega_\alpha} = \frac{2.2}{\omega_\alpha} \qquad (3)$$

provided the transistor does not saturate, i.e., remains in the active region.

If the transistor is driven to the point of saturation, $I_{cs} \approx V_{cc}/R_L$ (the lower the collector-to-emitter saturation voltage, the more accurate this approximation). The input current step required to drive the transistor to the point of saturation is:

$$I_{1SAT} = \frac{I_{cs}}{\alpha_{of}}$$

When $I_1 > I_{1SAT}$, I_c goes from zero (actually I_{CBO} if the emitter is dc open) to I_{cs} in a time t_o. If R_L does not load the transistor then:

$$t_o = \frac{1}{\omega_\alpha} \ln \frac{\alpha_{of} I_1}{\alpha_{of} I_1 - I_s} \qquad (4)$$

In the common emitter configuration, the response of the transistor to a base input step circuit I_1 is:

$$i_c = -\frac{\alpha_{of}}{1-\alpha_{of}} I_1 \left(1 - e^{-(1-\alpha_{of})\omega_\alpha t}\right) \qquad (5)$$

From which the common-emitter response equations as derived by J. J. Ebers and J. L. Moll* are:

$$t_r\ (\text{risetime}) = \frac{1}{(1-\alpha_{of})\,\omega_{\alpha f}} \ln \frac{i_{B1}}{i_{B1} - 0.9\,(1-\alpha_{of})\,i_c/\alpha_{of}} \qquad (6)$$

$$t_s\ (\text{storage time}) = \qquad (7)$$

$$\left[\frac{\omega_{\alpha F} + \omega_{\alpha R}}{\omega_{\alpha F}\,\omega_{\alpha R}\,(1-\alpha_{oF}\,\alpha_{oR})}\right] \ln \left[\frac{i_{B1} - i_{B2}}{\dfrac{i_{c1}\,(1-\alpha_{oF}) - i_{B2}}{\alpha_{oF}}}\right]$$

$$t_f\ (\text{fall time}) = \qquad (8)$$

$$\frac{1}{(1-\alpha_{oF})\,\omega_{\alpha F}} \ln \left[\frac{i_{c1} - \dfrac{\alpha_{oF}\,i_{B2}}{1-\alpha_{oF}}}{\dfrac{0.1\,i_{c1} - \alpha_{oF}\,i_{B2}}{1-\alpha_{oF}}}\right]$$

(*Large Signal Behavior of Junction Transistors, Proc. IRE, Vol. 42, pp 1761-1762, Dec. 1954).

(The accuracy to be expected from these equations is about 20 per cent.)

α_{of} = Forward common-base small signal-current gain.
α_{oR} = Collector and emitter reverse common-base small signal-current gain.
ω_{af} = Forward α_{of} cut-off angular frequency.
ω_{aR} = Collector and emitter reverse cut-off angular frequency.
i_{B1} = Forward base current.
i_{B2} = Reverse base current.
i_{c1} = Collector current at saturation.

Graphically the switching times are defined as shown in Fig. 3*a* and *b*.

The circuit constants for a pnp transistor are shown in Fig. 4. (For an npn transistor, all the signs are reversed.)

$$i_{c1} = -\frac{V_{cc}}{R_L} \quad (9)$$

$$i_{B1} = -\frac{V_1}{R_B} \text{ at } \Delta t = t_1 \quad (10)$$

$$i_{B2} = -\frac{V_2}{R_B} \text{ at } \Delta t = t_2 \quad (11)$$

The signs are correct since both currents are out of the transistor.

The rise-time equation is based on the assumption that there is no capacitive loading (including the effect of the collector capacitance), i.e., $\omega_{aF} C_c R_L << 1$. If there is capacitive loading and/or R_L is unduly high, the same treatment applies; however, the transient time would be larger.

Rise Time Can Be Rapidly Found Using Nomograph

As previously given:

$$t_r = \frac{1}{(1-\alpha_{oF})\ \omega_{aF}} ln \left[\frac{i_{B1}}{i_{B1} - \dfrac{0.9\ (1-\alpha_{oF})\ i_c}{\alpha_{oF}}} \right]$$

$\dfrac{1-\alpha_{oF}}{\alpha_{oF}} \approx \dfrac{1}{h_{FE}}$ = Reciprocal common-emitter dc current at a particular I_{c1} level for a high α_{oF}.

$$t_r = \frac{1}{(1-\alpha_{oF})\ \omega_{aF}} ln \left[\frac{i_{B1}}{i_{B1} - 0.9\ i_c/h_{FE}} \right] \quad (12)$$

$$t_r = \frac{1}{(1-\alpha_{oF})\ \omega_{aF}} ln \left[\frac{i_{B1}/i_{c1}/h_{FE}}{\dfrac{i_{B1}}{i_{c1}/h_{FE}} - 0.9} \right] \quad (13)$$

h_{FE} represents the actual current gain of the transistor. However, i_{c1}/i_{B1} represents the "forced" current gain (B_F) of a transistor in a particular circuit and is a function of the circuit parameters only if $h_{FE} > B_F$.

For example, in Fig. 4:

$$B_F = i_{c1}/i_{B1} = \frac{-Vcc/R_L}{-V_1/R_B} = \frac{Vcc\ R_B}{V_1 R_L}$$

Rewriting Eq. 13 to a more convenient form

$$t_r = \frac{1}{(1-\alpha_{oF})\ \omega_{aF}} ln \frac{h_{FE}/B_F}{h_{FE}/B_F - 0.9} \quad (14)$$

Thus, the rise time of a transistor can be decreased by manipulating the ration h_{FE}/B_F which will be called the gain factor (G_1).

$$\therefore t_r = \frac{1}{(1-\alpha_{oF})\ \omega_{aF}} ln \frac{G_1}{G_1 - 0.9} \quad (15)$$

Fortunately Eq. 15 is in a form which easily lends itself to the nomograph shown in Fig. 5.

To illustrate the use of the rise time nomograph, consider the following common emitter switching circuit:

For the circuit:

N_{cc} 1 = 10 v
R_L = 1 K
R_B = 3 K

For the transistor:

h_{FE} = 50 at i_{c1} = 10 ma when the transistor is in saturation.
ω_{aF} = 10^7 radians/sec.

Solution:

1. $f_{\alpha co}$ (alpha cut-off frequency) = $\dfrac{10^7}{2\pi}$ = 1.58 mc, plotted as point *A* on the nomograph.
2. $h_{FE} = 50$ at $i_{c1} = 10$ ma, plotted as point *B* on the nomograph.

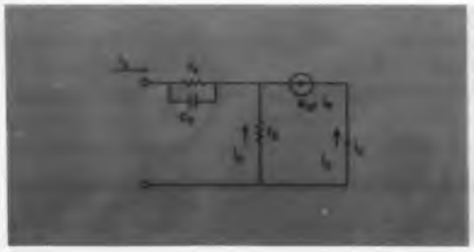

Fig. 1. Approximate equivalent circuit of a common base configuration with output short circuited.

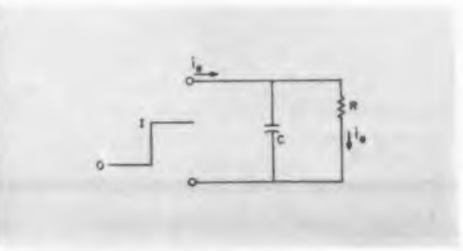

Fig. 2. An *RC* circuit used to simulate the relationship between current gain attenuation and frequency.

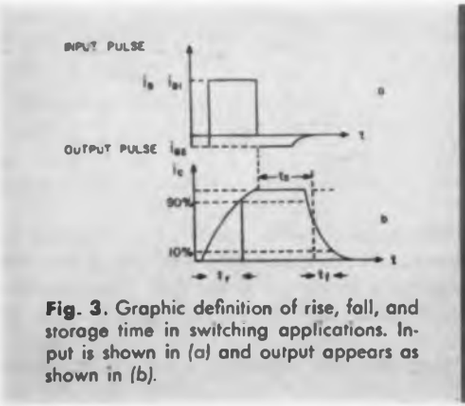

Fig. 3. Graphic definition of rise, fall, and storage time in switching applications. Input is shown in (*a*) and output appears as shown in (*b*).

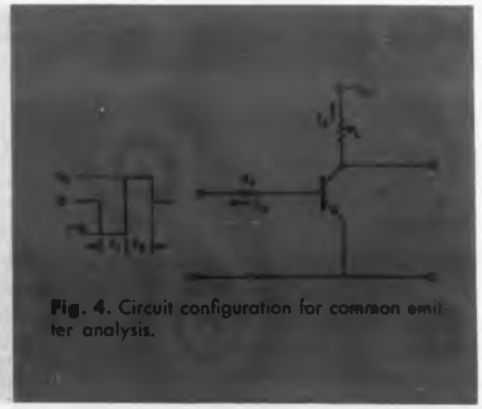

Fig. 4. Circuit configuration for common emitter analysis.

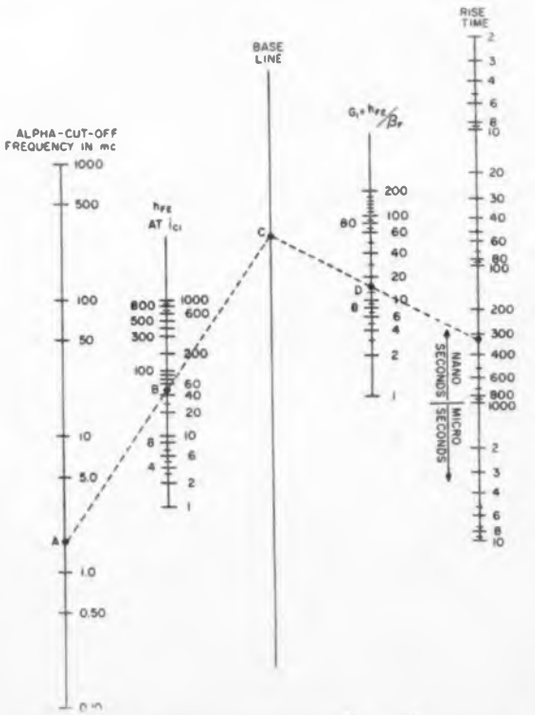

Fig. 5. Nomograph for rapid calculation of rise time using a common emitter circuit.

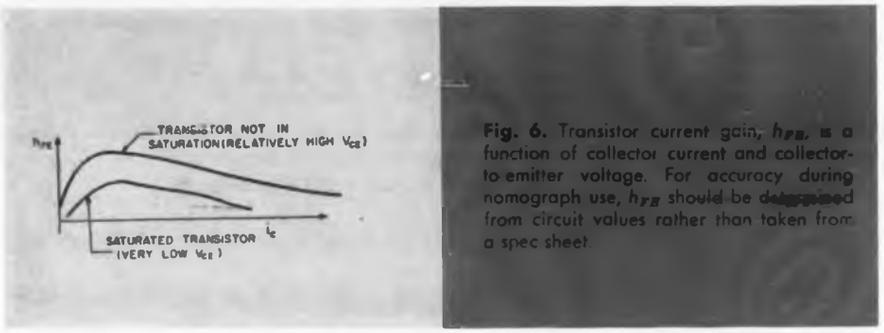

Fig. 6. Transistor current gain, h_{FE}, is a function of collector current and collector-to-emitter voltage. For accuracy during nomograph use, h_{FE} should be determined from circuit values rather than taken from a spec sheet.

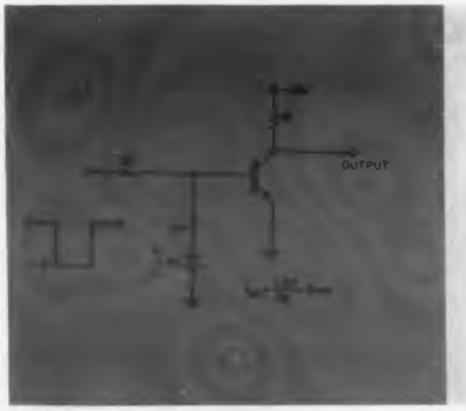

Fig. 7. Common emitter stage with reverse bias to supply "off" base current.

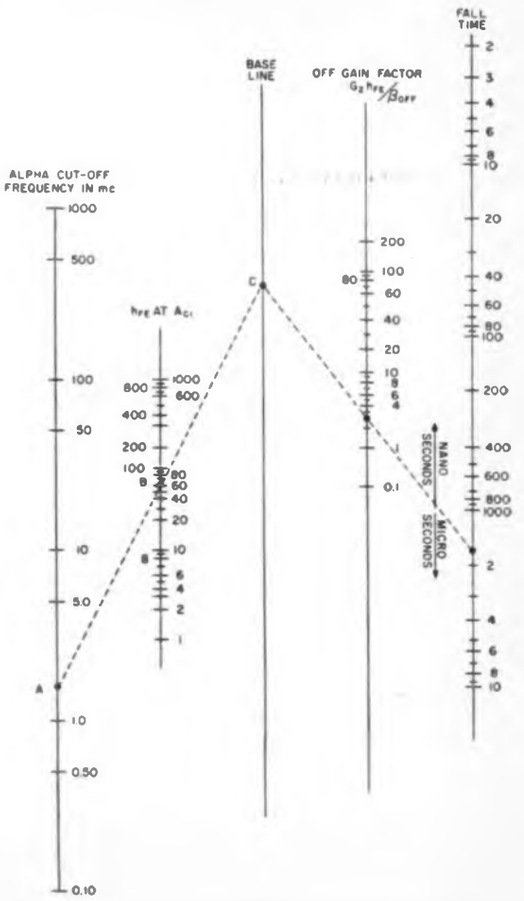

Fig. 8. Nomograph for fall-time calculation in common emitter circuit.

3. Points A and B are connected and extended to the base lines at point C.
4. The gain factor $G_1 = h_{FE}/B_F$.

$$B_F = i_{c1}/i_{B2} = \frac{-Vcc/R_L}{-V/RB} = \frac{10\,v/1\,K}{9\,v/3\,K} = \frac{10}{3} = 3.3$$

$$\therefore G_1 = \frac{50}{3.3} = 15.1$$

which is point D on the nomograph.
5. A line is drawn from C to D and extended to the time scale where the rise time is found to be 320 nsec. It can be seen that by driving the transistor harder, i.e., increasing i_B, the switching time could be increased. For example, if R_B was 1 K.

$$i_{B1} = 9.0\,v/1\,K = 9\ ma$$
$$B_F = 10.0/9.0 = 1.11$$
$$\therefore G_1 = 50/1.11 = 45$$

This would result in a switching time of 65 nsec, an improvement by a factor of almost 5. However, this is not always desirable in terms of switching times.

It is emphasized that the gain (h_{FE}) at a particular current level and saturation level (V_{CE}) be specified. Transistor current gain is a function of I_C and V_{CE} as shown in Fig. 6.

It can be seen from Fig. 6 that faster switching may be obtained from low and medium speed transistors by selecting a switching collector-current level which corresponds to the transistor-gain peak.

Storage Time Can Be Optimized For Fast Switching

The storage-time equation is:

$$t_s = \left[\frac{\omega_{\alpha F} + \omega_{\alpha R}}{\omega_{\alpha F}\,\omega_{\alpha R}\,(1-\alpha_{oF}\,\alpha_{oR})}\right] ln \left[\frac{i_{B1} - i_{B2}}{\frac{i_{c1}\,(1-\alpha_{oF})}{\alpha_{oF}} - i_{B2}}\right] \quad (7)$$

as before $1 - \alpha_{oF}/\alpha_{oF} = 1/h_{FE}$

$$t_s = \left[\frac{\omega_{\alpha F} + \omega_{\alpha R}}{\omega_{\alpha F}\,\omega_{\alpha R}\,(1-\alpha_{oF}\,\alpha_{oR})}\right] ln \left[\frac{i_{B1} - i_{B2}}{i_{c1}/h_{FE} - i_{B2}}\right] \quad (8)$$

and multiplying through by h_{FE}/i_{C1}

$$t_s = \left[\frac{\omega_{\alpha F} + \omega_{\alpha R}}{\omega_{\alpha F}\,\omega_{\alpha R}\,(1-\alpha_{oF}\,\alpha_{oR})}\right] ln \left[\frac{\frac{h_{FE}/i_{c1}}{i_{c1}} - \frac{h_{FE}\,i_{B2}}{i_{c1}}}{1 - \frac{h_{FE}\,i_{B2}}{i_{c1}}}\right] \quad (9)$$

The quantity i_{B2}/i_{C1} appears to be another inverted gain ratio; however, while i_{C1} is the "on" collector current, i_{B2} is the "off" base current, which causes the emitter current to reverse direction.

This does not affect the α_o of the transistor. The significance of $-i_E$ indicates that the col-

lector current starts to fall toward a negative value instead of zero which means the transistor turns "off" faster. Thus, i_{C1}/i_{B2} can be called "B_{off}."

$\therefore h_{FE}\, i_{B2}/i_{C1} = h_{FE}/B_{off}\, \Delta\, G_2$ (named the "off" gain factor). But G_2 is negative since i_{C1} and i_{B2} are in opposite directions, i.e., for a pnp transistor i_{B2} is flowing into the transistor and i_{C1} is flowing out of it. For a npn transistor i_{B2} is flowing out of the transistor and i_{C2} is flowing into the transistor. Thus:

$$t_s = \left[\frac{\omega_{\alpha F} + \omega_{\alpha R}}{\omega_{\alpha F}\ \omega_{\alpha R}\ (1-\alpha_{oF}\ \alpha_{oR})}\right] ln \left[\frac{G_1 + G_2}{1 + G_2}\right] \quad (10)$$

The above relationship does not lend itself to a simple nomograph because of the presence of the two gain factors G_1 and G_2, and the additional parameters $\omega_{\alpha R}$ and α_{oR}. However, a nomograph would be of no great value in determining storage time because reverse gain and reverse alpha cut-off frequency are rarely available as specified parameters and few manufacturers, if any, are willing to specify them as guaranteed minimum values.

From Eq. 10 it can be seen that increasing base drive, while decreasing rise time, serves to increase storage time. The circuit designer must determine how much storage time he can accept in order to obtain faster switching. Eq. 10 also shows how storage time can be decreased by increasing the "off" base current.

Other techniques are also available for limiting charge storage. The most obvious is by base "starving" (limiting the base current) or clamping to avoid saturation. In saturating type logic, a base "speed-up" or compensating capacitor is highly effective in reducing the charge storage effect.

Inspection of Fall Time Nomograph Yields Switching Speed

The fall time is determined by the following relationship:

$$t_s\,(\text{fall time}) = \frac{1}{(1-\alpha_{oF})\ \omega_{\alpha F}} ln \left[\frac{i_{c1} - \dfrac{\alpha_{oF}\ i_{B2}}{1-\alpha_{oF}}}{0.1\ i_{c1} - \dfrac{\alpha_{oF}\ i_{B2}}{1-\alpha_{oF}}}\right] \quad (8)$$

$$= \frac{1}{(1-\alpha_{oF})\ (\omega_{\alpha F})} ln \left[1 - \frac{h_{FE}\ i_{B2}}{i_{c1}}/0.1 - h_{FE}\ i_{B2}/i_{c1}\right] \quad (10)$$

as previously derived:

$$\frac{h_{FE}\ i_{B2}}{i_{c1}} \overset{\Delta}{=} h_{FE}/B_{oFF} = -G_2$$

$$\therefore t_f = \frac{1}{(1-\alpha_{oF})\ \omega_{\alpha F}} ln \left[\frac{1 + G_2}{0.1 + G_2}\right] \quad (11)$$

Here again the resulting equation for fall time lends itself to a nomograph, shown in Fig. 8.

To illustrate the use of the fall-time nomograph consider the same circuit as used in the previous example with the addition of a network which serves to reverse bias the emitter junction in order to provide the "off" base-current i_{B2}. It is understood that when using the transistor as a switch the input pulse magnitude must be sufficient to overcome the reverse bias.

As before, $h_{FE} = 50$ at $i_{C1} = 10$ ma for the saturated transistor and $f_{\alpha co} = 1.58$ mc.

Solution:

1. Plot $f_{\alpha co} = 1.58$ mc on Fig. 8 as point A.
2. Plot $h_{FE} = 50$ at $i_{C1} =$ ma as point B.
3. Connect A and B and extend the line to point C on the base line.
4. Compute the "off" gain-factor $G_2 = h_{FE}/B_{off}$.

$$|B_{off}| = i_{c1}/i_{B2} = \frac{10\text{ ma}}{0.5\text{ ma}} = 20$$

$G_2 = 50/20 = 2.5$ which is point D.

5. Points C and D are extended to the time scale where the fall time is found to be 1.7 μsec.

Observation of Fig. 8 shows that the fall time could be decreased by increasing G_2, i.e., increasing the "off" base current.

The advantage of a high i_{B2} is two-fold with respect to smaller switching times. As i_{B2} is increased, the storage time decreases (permitting harder drive current for smaller risetimes), and fall time decreases.

Another advantage of reverse biasing the transistor to provide an i_{B2} as shown in the example, is the departure from the dc open base to emitter configuration. The open-base avalanche voltage is the limiting collector voltage in the common emitter configuration. If the base is dc open, then $|V_{CC}|$ must be less than $|V_{CEO}|$. However, if the base is reversed biased, a higher collector supply voltage is permissible for reliable operation.

Additional High-Frequency Parameters Are Also Specified

Alpha-cut-off frequency has been the frequency parameter used throughout the analysis. It is the one most often given as part of transistor specifications because it is one of the simplest frequency parameters to measure in transistors having an $f_{\alpha co} < 50$ mc.

Listed below are some other frequency parameters specified by transistor manufacturers and their relationship to $f_{\alpha co}$. This permits use of the nomograph in cases where another frequency parameter is specified.

■ f_{MAX}:—Maximum frequency of oscillation—This is the maximum frequency at which the transistor will oscillate, i.e., the frequency at which the transistor has a tuned power gain of unity.

$$f_{max} = \sqrt{\frac{f_{\alpha co}}{25\ r_b\ C_c}}$$

r_b = total base resistance in ohms

C_c = collector capacity in farads

■ Gain bandwidth product: assuming the common emitter frequency response falls off at 6 db/octave, it is the frequency at which the common emitter short circuit current gain is unity.

$$f_t \simeq f_{\alpha co}/(1 + \alpha_{oF}\ m)$$

m is defined as the excess phase factor and can be computed from the following approximation:

$$\alpha = \alpha_o \frac{1 - jm f/f_{\alpha co}}{1 + jf/f_{\alpha co}}\ ;\text{or } m \simeq j\frac{f_{\alpha co}}{f} ln \frac{\alpha}{\alpha_o}\ (1 + j\ f/f_{\alpha co})$$

For a non-grade base transistor:

$$f_t = 0.82\ f_{\alpha co}$$

In general, depending on the transistor type, f_t ranges from 30 to 85 per cent of $f_{\alpha co}$.

■ Beta cut-off frequency: The frequency at which the common emitter current gain is 3 db less than its low frequency value.

$$f_B \cong \frac{f_{\alpha co}}{B}$$

It is not implied that every transistor can switch at any speed. Other limitations in driving transistors must be considered, such as, exceeding voltage ratings, power dissipations, and optimizing circuits for higher frequency responses. ■ ■

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Five Techniques For Improving Slide-Rule Accuracy

The electronic design engineer has been described as a man who uses his slide rule to multiply 2 by 2. He reads 3.98 as the product and assumes 4 is a close enough approximation for all practical purposes. In this article, B. R. Hatcher shows how the same engineer can use a slide rule to read answers with four or more significant digits.

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THOUGH the accuracy of a 10-in. slide rule is limited to about 0.1 per cent for a single setting, accuracy can often be improved considerably by computing correction terms, rather than the whole quantity.

Five general methods are outlined here which, singly or in combination, can often be used to increase slide-rule accuracy.

Like any other "tricks," they are useful for special cases. But one cannot indicate a definite point beyond which they are no longer practical. This indication comes only with practice and experience. Nevertheless, the principle of computing correction terms instead of direct quantities will always tend to increase the accuracy of operations involving numbers of three or more digits—even where this accuracy does no more than increase the readability of the least significant figure.

1 Computation Technique For Quotients Near Unity, 10, Etc.

Use of the slide rule to compute only the difference from unity will increase accuracy of calculation by one significant figure. For example:

$$\frac{2.785}{2.754} = \frac{2.754 + 0.031}{2.754}$$

$$= 1 + 0.0112(6) = 1.0112(6)$$

Computing directly, one obtains

$$\frac{2.785}{2.754} = 1.01(1)$$

where the parentheses indicate that this figure is of doubtful accuracy.

This method will give greatly increased accuracy though the denominator can be set to only three digits accurately, that is 2.75. Notice that in the first case, the result is quite accurate to five significant figures, while in the second, it is accurate to only three. Another example is:

$$\frac{96.75}{9.862} = \frac{98.620 - 1.87}{9.862}$$

$$= 10 - 0.189(6) = 9.810(4)$$

Note that instead of unity, another digit may result as

$$\frac{6.8474}{3.4131} = \frac{6.8262 + 0.0212}{3.4131}$$

$$= 2 + 0.0062(2) = 2.0062(2)$$

However, this requires more mental arithmetic, and is consequently a little more difficult. For this method to increase the number of significant figures to five, the fraction must be such that the second significant figure is either one or zero. In any other case, the result will be accurate only to four significant figures.

2 Technique for Simplifying Denominator of Proper Fraction

If additions are made to the numerator and denominator of a fraction in the same proportion as the original numerator and denominator, the value of the fraction is the same. Thus,

$$\frac{x}{y} = \frac{x + d\frac{x}{y}}{y + d}$$

For example:

$$\frac{621}{982} = \frac{621 + 18\left(\frac{621}{982}\right)}{1000}$$

$$= \frac{621 + 11.4}{1000}$$

$$= 0.6324$$

If the fraction is an improper fraction, it can

always be reduced as in the first method. For example:

$$\frac{528}{248} = 2 + \frac{32 + 752\left(\frac{32}{248}\right)}{248 + 752}$$

$$= 2 + \frac{129}{1000}$$

$$= 2.129$$

Notice that the denominator need not be reduced to unity, but may be reduced to 2, 5, or any other digit which may be divided with ease mentally. Taking the same example,

$$\frac{528}{248} = 2 + \frac{32 + 252\left(\frac{32}{248}\right)}{248 + 252}$$

$$= 2 + \frac{64.5}{500}$$

$$= 2.129$$

This method does not always increase the number of significant digits in the solution, but it does tend to fix the third digit more precisely than does straightforward division.

3 Computation Technique For Multiplication

By multiplying the first digit accurately, and using the slide rule only for the less important numbers, accuracy can be greatly enhanced. For example:

$$\begin{aligned}(753.5)\,(1.056) &= 753.5 + (753.5)\,(0.056)\\ &= 753.5 + 42.2\\ &= 795.7\end{aligned}$$

Direct slide-rule computation gives 795.(0); the true value is 795.696.

In cases where the fractional part of the term which is to be separated is greater than 0.5, a slight modification of this method is necessary to insure greater accuracy. For example:

$$\begin{aligned}(753.5)\,(1.886) &= (753.5)\,(2) - (753.5)\,(0.114)\\ &= 1507.0 - 85.9\\ &= 1421.1\end{aligned}$$

Here the correction term is subtracted instead of added.

4 Technique for Differences Of Nearly Equal Fractions

For accuracy, the differences of nearly equal numbers must be computed very carefully. In finding the difference between two very nearly equal fractions, one should not try to evaluate each fraction individually. One should reduce

them to a common denominator first, then use the slide rule. For example:

$$\frac{603}{3008} - \frac{1}{5} = \frac{3015 - 3008}{15040}$$

$$= \frac{7}{15040}$$

$$= 0.000{,}465$$

Reducing each fraction first yields $0.200(5) - 0.2000 = 0.000(5)$, with *no* accurate significant figures. To nine significant figures, the actual value is 0.000.465,425.

Since the difference is very small, the common denominator of the fraction need not be located so accurately on the slide rule. The first three significant figures suffice. For example, by manual computation one obtains

$$\frac{603}{3008} - \frac{1}{9} = \frac{5427 - 3008}{27072}$$

$$= \frac{2419}{27072}$$

$$= 0.089{,}354$$

On the slide rule, one would actually calculate

$$\frac{242}{271(0)} = 0.0894$$

while by reducing each fraction first, one obtains

$$0.200(?) - 0.1111 = 0.089(?)$$

Thus, by reducing to a common denominator first, one gains one more significant figure. On occasion, one may find it necessary to use one of the previous methods to obtain greater numerator accuracy. This method finds its greatest value when the difference between the two fractions is in the second or third significant figure. When this is not the case, that is, when the difference is not too small, the direct use of the methods in Section 1 or 2 will usually give better results. For example:

$$\left(\frac{1758}{1690} - \frac{1182}{1163}\right) = \left(1 + \frac{68}{1690}\right) - \left(1 + \frac{19}{1163}\right)$$

$$= 1.0402 - 1.0163$$

$$= 0.0239$$

By reducing the fractions directly with a slide rule, one obtains $1.04(0) - 1.01(6) = 0.02(4)$. To six decimal places, the actual value is 0.023,894.

The second example cited in this section (4)

really belongs in this realm, and would be performed as follows.

$$\left(\frac{603}{3008}-\frac{1}{9}\right)=\left(\frac{601.6+1.4}{3008}\right)-\left(\frac{0.9+0.1}{9}\right)$$

$$=\left(0.2+\frac{1.4}{3000}\right)-\left(0.1+\frac{0.1}{9}\right)$$

$$=(0.2+0.000465)\ -\ (0.1+0.01111)$$

$$=0.089,354$$

which to six decimal places, is its exact value.

5 Factoring Technique For Binomial Expansion

In the binomial expansion

$$(a+b)^n=a^n+na^{n-1}b+\frac{n(n-1)a^{n-2}b}{2!}+\ldots$$

one of the terms can always be made unity by factoring.

$$(1+d)^n=1+nd+\left[\frac{n(n-1)}{2!}d^2\right]+\ldots$$

where $d=b/a$.

If d is much smaller than unity, the powers of d greater than the first may be neglected without introducing appreciable error. The first two terms are generally used; the term in brackets is usually dropped, but it may be used for greater accuracy. Thus (for $d \ll 1$):

$$\frac{1}{1\pm d}\simeq 1\mp d+[d^2]$$

$$\sqrt{1\pm d}\simeq 1\pm \tfrac{1}{2}d-[1/8\,d^2]$$

$$\frac{1}{\sqrt{1+d}}\simeq 1\mp \tfrac{1}{2}d+[3/8\,d^2]$$

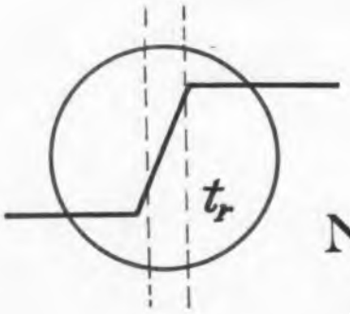
One application of this is in the solution of right triangles with one short side. If a = longer side, b = shorter side, c = hypotenuse, then

$$c=(a^2+b^2)^{\frac{1}{2}}=a\left(1+\frac{b^2}{a^2}\right)^{\frac{1}{2}}$$

$$\simeq a+\frac{b^2}{2a}$$

A similar expression can be used in reverse. Thus

$$a\simeq c-\frac{b^2}{2c}\ \blacksquare\blacksquare$$



Nomograms to Correct Rise-Time Measurements

After working for almost eight years on missile projects (Terrier and Polaris), author R. J. Ransil was transferred to Lockheed's Computer Electronics Dept. where he is developing high-speed switching circuits for special purpose computing equipment. He developed the rise-time correction nomograms shown here to save himself time and to provide more accurate rise-time measurements.

R. J. Ransil
Research Specialist
Lockheed Aircraft Corp.
Missile Systems Div.
Sunnyvale, Calif.

A SET of nomograms can help provide more meaningful measurements of pulse rise times with oscilloscopes. Frequently, observed waveforms have rise times nearly as fast as that of the oscilloscope used for measurement. In such cases the scope's own rise time can account for a considerable portion of the observed rise time, and a correction must be made to obtain an ac-

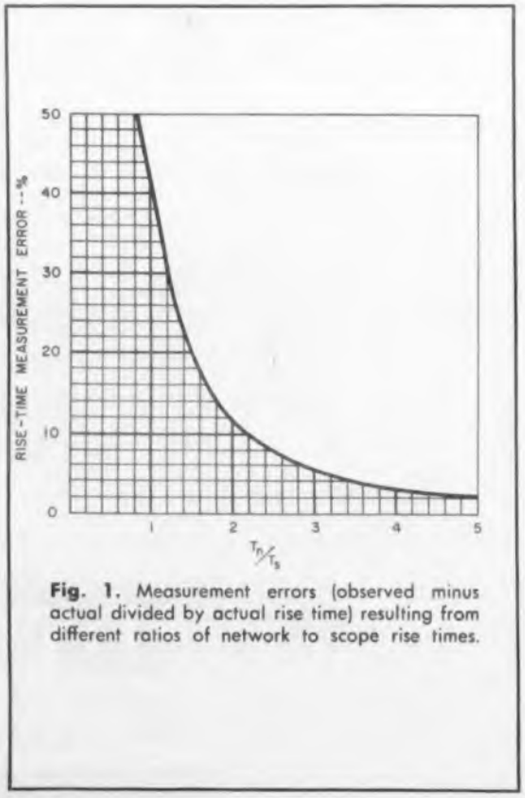


Fig. 1. Measurement errors (observed minus actual divided by actual rise time) resulting from different ratios of network to scope rise times.

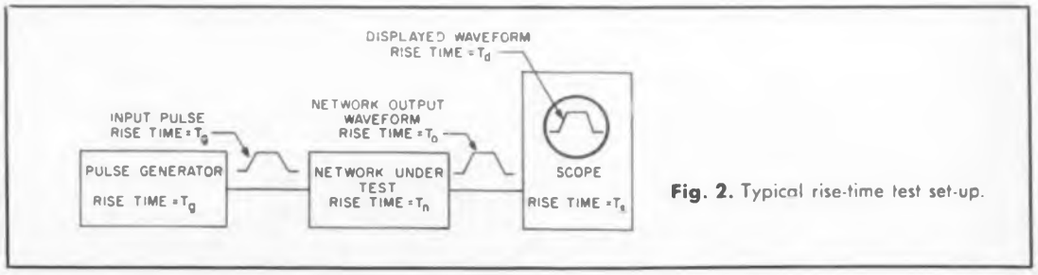


Fig. 2. Typical rise-time test set-up.

Tektronix Interchangeable-Preamp-Scope Rise Times (nsec)

Preamp Model	Scope Model: 531 535 536	531A 535A 533	541 541A 543 543A 545 545A 555	551	581 585	Gain Control Setting
A, 53A and 53/54A	35	25	18	20	—	All
B, 53B and 53/54B	40	35	30	30	—	5 mv/cm to 0.05 v/cm
B, 53B and 53/54B	35	25	18	20	—	0.05 v/cm to 20 v/cm
CA, 53C and 53/54C	35	23	15	16	—	All
G, 53G and 53/54G	35	25	18	20	—	All
H, 53H and 53/54H	37	31	23	25	—	All
K and 53/54K	31	23	12	14	—	All
L and 53/54L	35	23	15	17	—	5 mv/cm to 2 v/cm
L and 53/54L	31	23	12	14	—	0.05 v/cm to 20 v/cm
N*	0.6	0.6	0.6	0.6	—	All
80	—	—	—	—	3.5	All

*Denotes sampling system

High-Speed Scope Rise Times (nsec)

Model	Rise Time
Tektronix 316	35
" 507	5
" 511, 511A, 511AD	35
" 513D	25
" 514, 514A, 514AD	40
" 515, 515A	23
" 516	23
" 517, 517A	7
" 519	0.35
" 945 with MC Preamp	15
Hewlett Packard 160A,	
160B with 162 Preamp	< 25
185A with 187A Preamp*	< 0.7
150A, 150B	< 35
Edgerton Germeshausen & Grier	
707, 708, 2236A	0.2
Dumont 425	10.
Lumatron 12*, 112*	0.4

*Denotes sampling system

curate rise-time figure for the response of the network being tested.

Where the network is driven from a source like a pulse generator, the output waveform includes the rise time of the driving pulses. If the generator rise time is a significant portion of the total, and if the rise-time characteristic of the network alone is desired, a correction must also be made for the input-pulse rise time. The accompanying nomograms are also useful for that calculation.

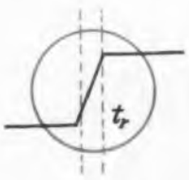
Nomogram Can Isolate Network Rise Time

The nomograms facilitate the calculation of actual rise time from the observed rise time and that of the oscilloscope. A table of advertised scope rise times includes all known scopes that are suitable for nanosecond pulse work. Unfortunately, scope manufacturers rarely provide tolerances for rise-time specifications, nor do they provide calibration data for individual scopes.

Consequently, it is difficult to judge just how accurate the listings are. In all except the most critical cases, catalog specifications should be accurate enough for the correction described here. Even in critical cases, reasonable accuracy can be assured by a technique described later.

Rise-Time Error Expressed as Ratio

The difference between observed rise time and actual rise time compared with the actual rise time can be expressed as an error in terms of the ratio of the actual network rise time to the scope rise time. A plot of rise-time error as a function of that ratio is shown in Fig. 1 as a basis to determine whether the rise-time correction is



a necessity or not.

Notice that a ratio of five to one (where the scope rise time is five times faster than the measured rise time) produces an error of about two per cent. Usually errors that small are not significant in rise-time measurement. No correction need be made in such cases. On the other hand, notice how large the error is at a one-to-one ratio and how rapidly it increases.

Waveform rise times in the test set-up shown in Fig. 2 can be determined from the following expressions:

$$T_o^2 = T_d^2 - T_s^2$$
$$T_n^2 = T_o^2 - T_g^2$$

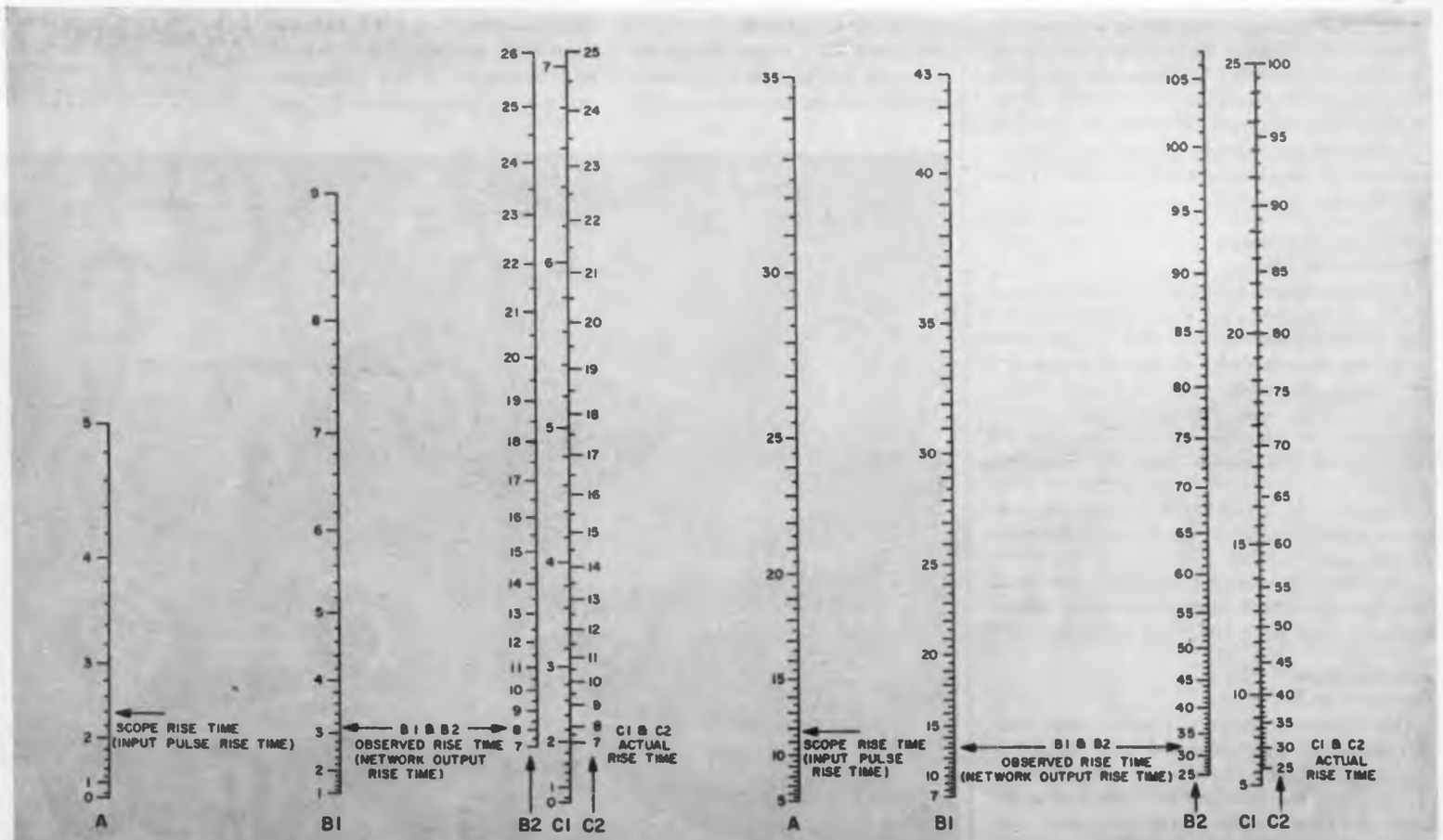
where T_o = rise time of network output waveform
T_s = rise time of oscilloscope
T_n = rise time of network only
T_g = pulse generator rise time

These are approximate expressions, but they are quite accurate if the observed overshoot is less than five per cent. Larger overshoots result in correspondingly less accurate results. The accompanying nomograms solve the expressions for the output-waveform rise time (T_o) and actual network rise time (T_n).

The nomograms can be used for almost any measurement problem involving rise-time correction by simple scale-factor adjustments. They can be used for transient-response measurements on low-frequency systems where the inputs are step functions and the outputs are monitored by oscillographic recorders. In such cases the unit of milliseconds might be a convenient timing-scale factor.

Broken Nomograms Increase Accuracy

The nomograms are broken into several ranges to allow reasonable accuracy without excessive scale lengths. Nomogram 1 covers the range of scope (or pulse generator) rise times



Nomogram 1. Correction for Fast Rise Times. All scales are in nanoseconds but any convenient factor can be applied.

Nomogram 2. Correction for Slower Rise Times. All scales are in nanoseconds but any convenient factor can be applied.

Clevite's rectifiers find broad use as general purpose diodes in computers and as rectifiers in magnetic amplifiers, dc to dc converters and power supplies.

They are particularly useful in airborne applications where switching of equipment may generate high voltage transients in the line which would burn out ordinary diodes. Designed for maximum reliability, Clevite rectifiers provide high dissipation — 600 mw . . . high voltage — up to 600 v . . . high temperature — up to 150 ma at 150 C.

Where fast switching is not required, these rectifiers offer definite advantages in size, costs and superior overload protection. They are available in military types conforming to MIL-E-1, 1143 (USAF).

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from 0 to 5 nsec and actual rise times (on two scales) from 0 to 25 nsec. These scales are usable down to about 1/2 nsec for scale *A* (scope and generator scale) and as low as 1 nsec for the output waveforms.

On the low-speed end, Nomogram 2 extends coverage to 35 nsec for the scope or input pulse and 100 nsec (again on two scales) for the actual rise time. This is adequate coverage for most high-speed pulse work, but the scales can be extended in either direction to include any range by shifting decimal points as required on all the scales used for a given problem.

Scales *B1* and *C1* are used along with scale *A* to cover one range of outputs. Scales *B2* and *C2* are used with scale *A* to cover another range of outputs. This is true for both nomograms.

Sample Calculation Shows Nomogram Use

The following sample calculation is used as an example:

Scope rise time	3 nsec
Input pulse rise time	1.5 nsec
Observed rise time	5 nsec

Find the network's actual rise time.

Nomogram 1 (Scales *A*, *B1* and *C1*) covers the proper range for this case.

1. Draw a straight line from 3.0 on scale *A* through 5.0 on scale *B1*. The line intersects scale *C1* at 4.0. Therefore, the output rise time is 4.0 nsec.

2. The rise time of the network alone is now found by drawing another line from 1.5 (input-pulse rise time) on scale *A* through 4.0 (network-output rise time found in Step 1) on scale *B1* to scale *C1* which it intersects at about 3.7. The rise time of the network alone is then 3.7 nsec.

This is a typical case, and the measurement would be about 35 per cent in error if the correction were not made. [(5-3.7)/3.7].

If the oscilloscope and/or pulse-generator rise times are in doubt the network rise time can still be determined accurately by the following procedure. Connect the pulse generator (Fig. 2) directly to the oscilloscope input and record the rise time of the observed waveform. This measurement includes both the rise time of the oscilloscope and that of the pulse generator; so one calculation with the nomograms (using this measurement as "scope rise time") will yield the actual rise time of the network alone. ■ ■

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Plotter Locates to 0.001 In. Over 48-In. Square

THE ABILITY to plot digital information within the resolution of a 0.001-in. grid over a 48-in. by 48-in. surface may open up new application areas for plotting-type equipment.

The Gerber Scientific Instrument Co., 89 Spruce St., Hartford, Conn., said that it has received inquiries for its recently developed point plotter which can:

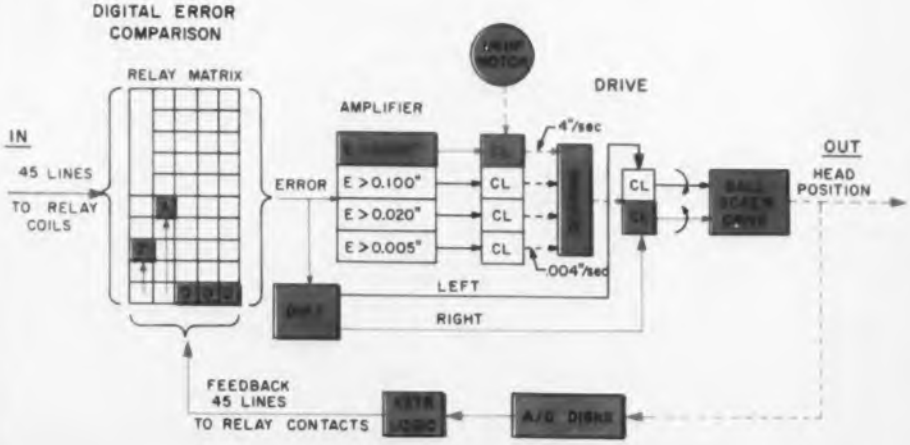
- Lay out master patterns for microcircuit deposition.
- Plot verifications for computer-generated machine tool programs.
- Perform light plastic machining operations. If the routing tool has "Z" axis motion, the plotter is converted into a "numerical milling machine for making relief maps.
- Reading point positions by using the cross-hair viewer supplied with the plotter.

Compared to the analog bridge-balance servo systems which Gerber and others have been using for plotters, the digital servo system used in the new plotter is said to be 15 times more accurate. However, it is also 50 per cent more expensive and (in its present form) 50 per cent slower. The cost of the 48 in. x 48 in. plotter is from $60,000 to $70,000.

The schematic shows the X axis control. The Y axis is identical.

Head position feedback information is digitized by four analog-to-digital conversion discs geared in descending fashion to one end of the ball screw shaft. The first disc has both the thousandths and the hundredths of an inch information, and the remaining three discs have the other decimal positions.

A transistorized non-ambiguity circuit, followed by a diode-resistor circuit (not shown), gates this information to the respective contacts of the relay matrix. There are 45 lines going to each of the relays. If the head were at the left side of the plotter, the bottom or "zero" row of relays would have power going to their contacts.



Schematic shows how relay matrix, clutches, ball screw and analog-to-digital discs make up the digital servo loop.

The input command also consists of individual lines carrying the decoded information from the tape to the respective relays, but in this case to the coils of the relays. Once an input pulse has closed a relay, it is electrically latched closed until a signal indicates that the point has been plotted. The command for mid-position or 24.000 in. is shown.

The digital-error signal from the relay matrix is generated by the discrepancy between relays with coils energized and those with contacts energized or vice versa. The logic is arranged to note the sense of this discrepancy and drive the head to "uncount" this. However, it should be noted that this is not a counting register arrangement but a wired-in matrix. This means that the correct feedback information will appear on the relay matrix whenever the machine is turned on and also that it cannot "lose count."

Following through the example shown on the schematic, where the command is X=24.000 in. and the head is at X=00.000 in., the first task for the logic is to detect what direction to go, then how fast.

Signals which indicated whether voltage existed on the "downstream" side of the relay contacts are used. In this case the logic detects that the coils are energized on relays "higher" than those on which the contacts are energized. It would first energize the lower clutch for right head motion.

Then, because the error is over 0.500 in., the drive speed logic energizes the "high speed" or 4 in./sec clutch drive to be closed. This connects the power from the constantly rotating 1/4 motor to gearing which drives the ball-screw nut attached to the carriage at 4 in./sec to the right.

The feedback system moves power up to higher relay contacts reducing the matrix discrepancy. When it has been reduced to 0.100 in., the 0.8 in./sec gearing is clutched in; at 0.020 in., the 0.08 in./sec gearing is clutched in, until finally, when the error has been nulled down to 0.005 in., the slowest speed of 0.004 in./sec is engaged and the head "inched" to null out the last relay discrepancy.

At the slowest speed, the time to travel the least increment (0.001 in.) is 250 μsec. Since the clutch can be disengaged in 12 μsec, the head can be positioned within its rated digital tolerance with some safety margin, David J. Logan, Gerber staff engineer said.

When "on target," the resulting coincidence in the relay matrix causes the pin prick or other tool in the head to be lowered and mark the spot.

For further information on this plotter turn to the Reader-Service Card and circle 251.

Important facts to know about laminated plastics

A few Taylor composite laminates (left to right): copper-clad section; sandwiched copper component; Taylorite vulcanized fibre-clad part; laminated tube, copper inserts.

Composite Laminates Open Up New Design Opportunities

While the great variety of commercially available laminated plastics satisfy most electrical and mechanical requirements, there are applications that can benefit from the combination of properties provided by composite laminates. Recent advances in bonding techniques have made it possible to bond virtually any compatible material with a laminate. These can be supplied as clad or as sandwiched materials. And they can be molded into many shapes to fit design requirements. Taylor is presently supplying to order the following composite laminates:

- **Copper and laminated plastics.** Clad for printed circuits and formed shapes. Sandwiched for special applications.
- **Taylorite® vulcanized fibre-clad laminates.** These combine the high strength of laminated plastics with the superior hot-arc-resistance of vulcanized fibre. They are being used in both high and low-voltage switchgear applications. Also in applications where the high impact strength of vulcanized fibre may be advantageous.
- **Rubber-clad laminates.** Almost any type of natural or synthetic rubber may be used as the cladding material. These laminates are widely used for condenser tops in wet condensers to protect the laminate against highly alkaline electrolytes. They also have application in any part where sealing or chemical resistance is needed.
- **Asbestos-clad laminates.** For applications where high heat- and arc-resistance are required.
- **Laminate-clad lead.** Lead sheets sandwiched between Grade XX paper-base laminates have been used for X-ray shields. The laminate provides strength and contributes to the high shielding properties of the lead.
- **Aluminum-clad laminates.** These have been used extensively for engraving stock. They also offer possibilities as printed-circuit material and as plate holders for X-ray machines.
- **Beryllium copper-clad laminates.** Beryllium copper is nonmagnetic and a good conductor—properties that give these laminates possibilities in many applications.
- **Stainless steel-clad laminates.** Applications where nonmagnetic properties are required. Also in certain corrosive environments where the resistance of stainless steel to attack is an asset.
- **Magnesium-clad laminates.** These laminates have been produced in 108-in.-long sheets for use as screens for X-ray operators. Weight was a factor.

Our design and production engineers are constantly developing new materials, new applications, and new procedures for fabricating laminated plastics. Our experience is yours for the asking. And if you have a problem requiring assistance or more information on composite laminates, write us. Also ask for your copy of Taylor's new guide to simplified selection of laminated plastics. Taylor Fibre Co., Norristown 48, Pa.

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NEW PRODUCTS

Interval Timer 700

This settable interval timer, designed for a low-altitude bombing system, is accurate to ±0.15 sec or ±1% through the full setting range, which is 0.2 sec to 28 sec in 0.2 sec increments. The 27-oz unit operates on 24 v dc. Its length is 6 in. and its OD is 2.2 in. Globe Industries, Inc., Dept. ED, 1784 Stanley Ave., Dayton 4, Ohio.

Indicator Light 701

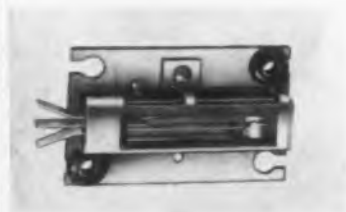
This lighted billboard indicator, model L5950, has an engraved legend visible when lit. The 1.124 x 0.312 in. unit is rated at 0.04 amp, 28 v; 0.08 amp, 14 v; and 0.2 amp, 6 v. Four lens colors are available. Controls Co. of America, Control Switch Div., Dept. ED, Folcroft, Pa.
Price: $13.50 ea.

Slip-Ring Assemblies 702

Available in sizes 8 to 23, these gold and silver slip rings are molded in resin to applicable MIL specifications. Concentricities are true to 0.001 in.; surface finish is 4 to 6 μ in. rms. Checked to 1500 v rms. Hollow, plug-in, and shaft-molded assemblies are stocked. Airflyte Electronics Co., Dept. ED, 535 Ave. A, Bayonne, N. J.

Terminal Switch 703

The model C124P3 heavy duty terminal switch is rated at 10 amp at 28 v dc resistive, 5 amp at 28 v dc inductive, 3 amp at 28 v dc lamp or 15 (0.75 pf) at 120 v ac. The normally-open switch requires 4-lb operating pressure. Controls Co. of America, Control Switch Div., Dept. ED, Folcroft, Pa.



Thermal Time Delay Relay 704

The type 59 is a single-pole, thermal time-delay relay with a period of 3 to 60 sec. It can be supplied with either normally-open or normally-closed snap-action contacts, and with ambient temperature compensation. It is available with 2, 3, or 4 terminals. Essex Wire Corp., RBM Controls Div., Dept. ED, Logansport, Ind.

Frequency Response Calculator

This pocket-sized frequency response calculator eliminates the need for slide-rule computations or complex chart references when plotting or interpreting response curves in the evaluation of amplifiers, transducers, etc. *Send $1 to Charles S. Cotton, Hagan Chemicals & Controls, Inc., Dept. ED, Hagan Center, Pittsburgh 30, Pa.*

Counter Units 598

Developed for use in a miniature time-temperature recorder, these counter components weigh less than 3 oz, and measure 1¼ x 3¾ x 2¼ in. including the actuating coil. Power consumption is 4 w. Stringent vibration and shock requirements are met.

Durant Mfg., Dept. ED, 1993 N. Buffum St., Milwaukee 1, Wis.

Silicone Rubber 600

This fluid silicone rubber, Silastic RTV 521, has a low viscosity for simplified and improved potting and encapsulating. It cures without external heat in 24 hours, and remains rubbery from —70 to 500 deg. F.

Dow Corning Corp., Dept. ED, Midland, Mich.
Price: *$4.95 to $3.90 per lb.*
Availability: *From stock in 1, 10, 50, and 75 lb cans.*

Molding Material 601

This high-temperature molding material, RX 600, is a glass-reinforced phenolic that is resistant to moisture and heat. It will withstand 450 deg F continuously. Ignition time in flame is 350 sec. Dielectric constant averages 4.53 at 1 mc.

Rogers Corp., Dept. ED, Rogers, Conn.

Elapsed-Time Meter 602

An elapsed-time meter, Type BH-351, with or without reset knob and mounted from the front or the back of the panel, is available. Total circuit on-time is indicated up to 99,999.9 hr.

Westinghouse Electric Corp., Dept. ED, Box 2099, Pittsburgh 30, Pa.

Silicone Varnish 603

This Class H varnish, No. 981, cures at 150 C in 6 hr. It meets AIEE requirements for both 180 C and 220 C systems, and is suitable for impregnating control and power transformers up to 500 kva.

Dow Corning Corp., Dept. ED, Midland, Mich.
Availability: *From stock.*

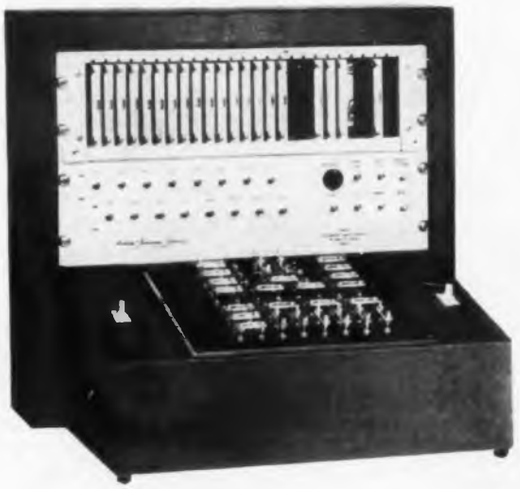
Liquid Resin 604

Parts may be protected during resin coating or potting with this liquid vinyl masking resin. After potting, the material, called Isochemmask, may be removed with its companion solvent or by friction.

Isochem Resins Co., Dept. ED, 221 Oak St., Providence, R. I.
Price: *$8 for kit of 1 pt mask, 1 pt solvent.*
Availability: *From stock in 1 and 5 gal cans, 55 gal drums.*

NEW PRODUCTS

Covering all new products generally specified by engineers designing electronic original equipment. Use the Reader's Service Card for more information on any product. Merely circle number corresponding to that appearing at the top of each description.



Reliability Tester 638
For Circuit Design Test

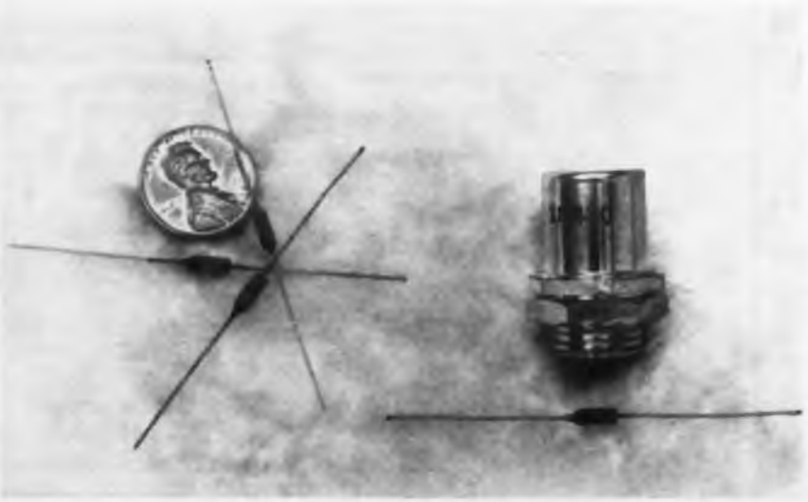
Type 90 circuit design reliability tester has been designed to rapidly and automatically test the reliability of complex circuits. It makes possible conducting over 65,000 tests on a circuit containing 16 parameters in about 11 min. Preliminary design of new circuits can be placed in the tolerance tester, failure trends noted and corrections made in the directions indicated.

Cutler-Hammer, Inc., Airborne Instruments Laboratory Div., Dept. ED, Deer Park, L. I., N. Y.
Price: *$3,600 including the CRO Signal Sensor.*
Availability: *Immediate.*

Medium Frequency Transistors 635
Have High Reliability

This pnp silicon precision alloy transistor (SPAT) is produced by a strip alloy technique which, it is claimed, makes possible unprecedented product uniformity. The eight types, T-2050, T-2057-62 and T-2071, all in TO-18 enclosures, are medium-speed devices designed for switching and control applications. They feature high-beta, very low saturation voltage and high emitter base diode voltage ratings. Characteristics of the T-2050 are: VCBO, 40 v; PD (25 C), 150 mw, max ICBO (10 v), 0.1 μamp; min f_T (6 v, 1 mc), 5 mc; hfe (6 v, 1 ma), min 30, max 120.

Philco Corp., Lansdale Div., Dept. ED, Lansdale, Pa.
Price: *From $5.90 for the T-2062 to $9.90 for the T-2050.*
Availability: *In production quantities, Jan. 1, 1961.*



Low-Impedance Diode 636
For Ultra-Stable Applications

Type 1N821A is a low-impedance, 6.2-v, temperature-compensated, Zener diode. It has been designed for ultra-stable reference applications in digital voltmeters, precision high-stability oscillators and analog to digital converters. It has a maximum impedance of 10 ohms and a typical value of 8 ohms. With this low dynamic impedance characteristic the diode minimizes voltage fluctuations due to changes in current. It is housed in the DO-7 axial-lead, 400-mw glass diode package.

Motorola Semiconductor Products, Inc., Dept. ED, 5005 E. McDowell Road, Phoenix, Ariz.
Price: *$4.90 ea in 100 and up quantities.*
Availability: *Immediate, from distributors.*

Ultrasonic Micro-Joiner Welds Wire As Fine As 0.0004 In. 634

This ultrasonic micro-joining unit can weld gold wire as fine as 0.0004 in. in diameter and join 0.0015 gold gallium alloy. It consists of an ultrasonic transducer hand-piece and four basic inserts. The set of inserts includes attachments for tweezer welds, a ball modification of the tweezer insert, a spot-welder, and a vibrator table. A table sized generator powers the unit. Micro-soldering without flux is possible with a special heating transformer, soldering iron and attachments for hot-plate soldering. Ultrasonic cavitational activity removes the oxide film.

Cavitron Corp., Dept. ED, Long Island City, N. Y.

Price: *$590 with the generator.*
Availability: *60 to 90 days.*

Function Generators Are Machine-Wound 633

This line of function generators is entirely machine-wound, making the over-all length of both pancake and standard embodiments less than that of conventional units. The size 11 unit is a totally compensated, 2-input, 2-output resolver which has an OD of 1.063 in., a total noise output of 1/2 mv per volt input and a maximum error of 0.025%. Torque as well as voltage functions of shaft angle are available. Digital switching, digital data transmission and reception, and digital word-formation and keying are applications of these miniaturized components. The photo compares it in size with a comparable hand-wound unit.

Belock Instrument Corp., Dept. ED, College Point 56, Long Island, N.Y.

Price: *About $400.*
Availability: *Pilot production in about 90 days.*

NEW PRODUCTS

Computer Linkage 659

Combines analog and digital

This computer linkage equipment permits combining a standard analog computer and one of several digital computers into a single system. Analog speed is thus combined with the high resolution, accuracy, and repeatability of the digital computer. Two basic systems, designated Models DS-110 and DS-113, offer 11-bit and 14-bit precision respectively. Both are available with up to 30 input and 30 output channels. The systems are designed for use with IBM 700-7000 Series, Bendix G-15, and Packard Bell PB 250 computers.

Packard Bell Computer, Dept. ED, 1905 Armacost Ave., Los Angeles 25, Calif.
Price: *Dependent on number of channels desired.*
Availability: *120 days.*

Commutating Switches 653

Speeds up to 3,600 rpm

This line of commutating, programming and sampling switches can be motor driven at speeds up to 3,600 rpm, or coupled to stepping motors, timing motors or manual drives. Rhodium-plated contact surfaces, bonded to dielectrics such as glass epoxy, paper epoxy or synthetic mica, are used with precious metal brushes. Packaging ranges from sealed sub-miniature modules to rack-mounting units. Any number of circuits, poles and contacts can be obtained in a single unit.

Rotary Devices Corp., Dept. ED, 40 Jay St., Englewood, N. J.
Availability: *30 to 45 days.*


S-Y

Reference Junction 647

Elevated temperature thermocouple

The model TRJ-3006 elevated temperature thermocouple reference junction is designed around an on-off type control system that operates on a small temperature differential. Variation is typically less than 1/6 F. Screw terminals allow direct thermo element contact.

Temptron, Inc., Dept. ED, 7030 Darby Ave., Reseda, Calif.

Phone Plug 650

1/25th standard volume

This miniature phone plug is 1/25th the volume of standard phone plugs. Called the Micro-Plug, it is available in a variety of handle materials and configurations. Tip is of machined brass, nickel-plated; insulation is molded nylon.

Switchcraft, Inc., Dept. ED, 5555 N. Elston Ave., Chicago 30, Ill.

Low Inductance Capacitor 690

Has 50-kv voltage rating

Low inductance capacitor, model 50E104, has a capacitance value of 1.0 μf and a voltage rating of 50 kv. It has an internal inductance of 15 nh and a ringing frequency of 1.3 mc. A life of 10,000 shots min is claimed, with 100% voltage reversal possible at 50 kv.

Axel Electronics, Inc., Dept. ED, 134-20 Jamaica Ave., Jamaica, N.Y.

NEW PRODUCTS

Telemetering Preamplifier 682

Range is 30 to 500 mc

Designed for low-noise preamplification in the range of 30 to 500 mc, the model 2009 preamplifier has a noise figure of 2 db at 50 mc, 4 db at 200 mc and 6 db at 500 mc. Bandwidth can be specified from 10 to 25 mc wide.

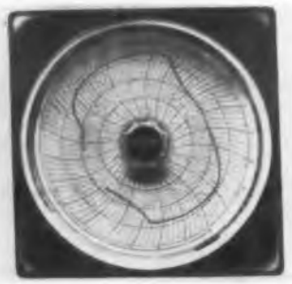
Community Engineering Corp., Dept. ED, P.O. Box 824, 234 E. College Ave., State College, Pa.

Price: *$650.*

Availability: *45 days.*

Chart Recorder 674

Prints with stylus



This miniature circular chart recorder is only 3-3/4 x 3-3/4 x 3 in. deep. It prints by means of a stylus on pressure-sensitive paper. Any variable which can be converted to an electrical signal can be recorded.

Thomas A. Edison Industries, Dept. ED, 61 Alden St., West Orange, N.J.

Temperature Controller 644

For up to 10 processes

Automatic 2-position control for up to 10 processes is provided by the Multi-Point controller.

It can be used as a single-point controller, a 5-point 3-position controller and a manual-balance indicator. Accuracy is 0.5% of range. Input signals are scanned at the rate of 3 sec per point; deviations from slide-wire control settings are amplified for relay control. A full line of accessories is available.

Thermo Electric Co., Inc., Dept. ED, Saddle Brook, N. J.

Price: *$1,650.*

Availability: *14-day delivery.*

Fixed-Station Antenna 687

For 30 to 50 mc

Type 902 fixed station antenna is designed for use in the 30 to 50 mc range. It employs a bifilar helical element in a Fiberglas encased radiator. The ground rods utilize single helix conductors. Light in weight, the type 902 antenna weighs 13 lb and is 40% smaller than conventional antennas at the same frequency.

Andrew Corp., Dept. ED, P.O. Box 807, Chicago 42, Ill.

Price: *$80.*

Availability: *From stock.*

Line-driven Chopper 651

Direct drive from 400 cps

The Model 64 plug-in transistor chopper can be driven directly from a 115-v, 400-cps line or from a drive source that is common to the dc voltage being chopped. Sinusoidal or square wave drive may be used. The inertialess device, capable of linearly switching or chopping from a fraction of a millivolt to 5 v, can be driven from a 100-cps to 10-kc sine-wave source or from a 40-cps to 15-kc square-wave source.

Solid State Electronics Co., Dept. ED, 15321 Rayen St., Sepuveda, Calif.

NEW PRODUCTS

Miniature Capacitors 619

Have Mylar dielectric

These Mylar miniature capacitors operate in a temperature range from —60 C to 125 C; tolerances from ±20% to ±1% are available. Voltages range from 100 to 600 v dc. Two types, MH and MHH, are hermetically sealed in metal cases with glass-to-metal end seals. Type MC is a cardboard tubular, and type MW is enclosed in Mylar tape with epoxy resin end seals. Non-inductive extended foil is used throughout with the leads soldered to the foil for minimum contact resistance.

Efcon, Inc., Dept. ED, Patterson Place, Roosevelt Field, Garden City, L.I., N.Y.

Hook-Up Wire 617

Operates to 1,000 F

Called Tetralene Type MGT, this hook-up wire operates reliably up to 1,000 deg F. The wire will maintain a minimum dielectric strength of 1 kv, and has been spark-tested at 2 kv. Insulation resistance is above 10,000 megohms. Conductor is nickel-plated copper, solid or stranded; primary insulation is 20-mil impregnated mica tape. The jacket is silicone-impregnated fiberglass braid. Size is AWG 6 to 26.

American Super-Temperature Wires, Inc., Dept. ED, W. Canal St., Winooski, Vt.

DC Power Supplies 615

0 to 50 v range

These semiconductor dc power supplies, the Series TP, are fully programmable and provide 0 to 50 v dc. They feature continuously variable current-limiting, line or load regulation of 0.1% or 0.01 v, and rms ripple of less than 1 mv. The 3 models are rated at 0.5, 1, and 3 amp. Metering and terminal arrangements are optional.

Electronic Measurements Co., Inc., Dept. ED, Eatontown, N.J.

PERFORMANCE LEADERSHIP

Motorola power transistors offer you outstanding design advantages. The "low silhouette" TO-36 devices offer the industry's highest power dissipation for germanium power transistors . . . 150 watts with an exceptional maximum thermal resistance of 0.5°C/W and a typical thermal resistance of 0.35°C/W. The TO-3 devices offer a 90 watt power dissipation capability and 0.8°C/W maximum thermal resistance . . . industry's best for this package design. Both units are rated for 100°C continuous junction operation.

WIDE SELECTION

Motorola provides a *standard* power transistor for nearly all of your design requirements. Over 100 different devices are offered in both the TO-3 "diamond" and TO-36 "doorknob" packages. Current ratings of 3, 5, 10, 15, and 25 amps, available with collector voltages to 120 volts. You have your choice of a variety of gain/voltage combinations to match your specific amplifier or switching circuit demands.

COMPLETE SPECIFICATIONS

Complete design information is available on each Motorola industrial power transistor. The industry's most comprehensive specification data sheets provide all essential details including: voltage characteristics, typical product traits, safe operating areas and power derating. In addition, Motorola provides competent applications assistance through published bulletins and personal consultation.

IMMEDIATE AVAILABILITY

Motorola industrial power transistors are available from stock in quantities up to 999 from 24 industrial distributors. Military-qualified units are also available through authorized distributors.

FOR ADDITIONAL INFORMATION

on Motorola Power Transistors write for technical literature. Address inquiries to Technical Information Department, Motorola Semiconductor Products Inc, 5005 East McDowell, Phoenix, Arizona. Please specify information desired.

MOTOROLA "LOW SILHOUETTE" TO-36 POWER TRANSISTORS

- 40 to 100 volts • 0.5 C/W maximum thermal resistance
- 150 watt power dissipation • 100°C junction temperature

15 AMP

h_{FE}	BV_{CEO}				
(V_{CE} = 2 V, I_C = 5 A)	40 V	50 V	60 V	80 V	100 V
20 - 40	2N441	2N442	2N443	2N174**	2N1100**
35 - 70	2N277	2N278	2N173	2N1099	——

**h_{FE} 25 - 50

MOTOROLA TO-3 POWER TRANSISTORS

- up to 120 volts • 0.8°C/W maximum thermal resistance
- 90 watt power dissipation • 100°C junction temperature

3 AMP

h_{FE}	BV_{CEO}			
(V_{CE} = 4 V, I_C = 1 A)	50 V	80 V	100 V	120 V
60 - 140	2N1360	2N618	2N1363	2N1365
35 - 90	2N1359	2N375	2N1362	2N1364

5 AMP

h_{FE}	BV_{CEO}				
(V_{CE} = 2 V, I_C = 3 A)	40 V	60 V	80 V	100 V	120 V
75 - 150	2N1544*	2N1545*	2N1546*	2N1547*	2N1548
50 - 100	2N1539*	2N1540*	2N1541*	2N1542*	2N1543
35 - 70	2N1534*	2N1535*	2N1536*	2N1537*	2N1538
20 - 40	2N1529*	2N1530*	2N1531*	2N1532*	2N1533

10 AMP

h_{FE}	BV_{CEO}			
(V_{CE} = 2 V, I_C = 10 A)	40 V	60 V	80 V	100 V
10 - 30 **TO-3 with solder lugs	2N627**	2N628**	2N629**	2N630**
10 - 30	MN61A	MN62A	MN63A	MN64A

15 AMP TO-3 packages with solder lugs also available

h_{FE}	BV_{CEO}			
(V_{CE} = 2 V, I_C = 10 A)	40 V	60 V	80 V	100 V
50 - 100	2N1557*	2N1558*	2N1559*	2N1560*
30 - 60	2N1553*	2N1554*	2N1555*	2N1556*
10 - 30	2N1549*	2N1550*	2N1551*	2N1552*

25 AMP TO-3 package with solder lugs available

h_{FE}	BV_{CEO}		
(V_{CE} = 1 V, I_C = 25 A)	50 V	80 V	100 V
15 - 65	2N1162*	2N1164*	2N1166*

MOTOROLA MILITARY POWER TRANSISTORS

	BV_{CEO}	h_{FE}, I_C		BV_{CEO}	h_{FE}, I_C
JAN 2N174	80 V**	40-80, 1.2A	2N1120 (Sig C)	80 V	10-50, 10 A
2N297A (Sig C)	80 V	20 min, 2 A	2N1120	80 V	10-50, 10 A
2N297A	80 V	20 min, 2 A	2N1358 (Sig C)	80 V**	40-80, 1.2 A
2N1011 (Sig C)	80 V	30-75, 3 A	2N1412 (USN)	100 V**	25-50, 5A
2N1011	80 V	30-75, 3 A			

**BV_{CEM}

*An "A" series of these devices is offered under the Motorola "Meg-A-Life" program . . . providing certified military-quality units for industrial applications.

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Semiconductor Products Inc.

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- ZENERS
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WOodlawn 4-8560

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EMerson 5-7551

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CApitol 4-2663

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REctor 2-4400

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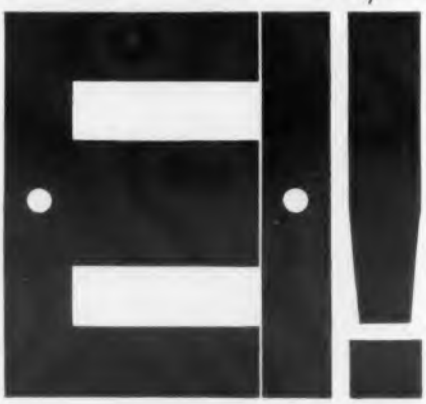

G-L's new lamination insulation process gives greater permeability than ever before!

Most nickel-alloy laminations have insulation coatings formed by high-temperature oxidation of the base-metal surface. This process produces generally satisfactory insulation. But at the same time it usually causes degradation of lamination permeability. ■ Our new "Hy-Q" insulation process eliminates the undesirable side effect. It makes it possible for us to retain the high permeability achieved by controlled hydrogen annealing. Result: greater — and more uniform — initial permeability in the stack. Better efficiency, too. ■ These performance improvements may allow you to reduce stack size . . . or get more output from the same size stack. Either way, production will be easier, for the "Hy-Q" coating — applied to both sides of the lamination — prevents sticking, facilitates handling. ■ You can have "Hy-Q" laminations in wide variety of shapes, sizes, materials, and standard thicknesses, with immediate delivery from stock. A word from you will bring detailed information. Ask for Bulletin TB 106.

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SA 2336

CIRCLE 46 ON READER-SERVICE CARD

NEW PRODUCTS

Video Amplifier 666

Transistorized, logarithmic

The Type LVT-1 is a fully transistorized logarithmic video amplifier. Use in conjunction with a crystal detector mount results in a crystal video receiver with a logarithmic input-output relationship. Dynamic range is 60 db; bandwidth is 4 mc. Individual stage feedback permits shaping of transfer characteristics. Pairs matched to within ±1.5 db can be supplied.

The W. L. Maxson Corp., Dept. ED, 475 10th Ave., New York 18, N. Y.

Strain Gages 629

Gage factor is 200

The MP Series of dual-element strain gages have 1 positive and 1 negative gage factor crystal, matched to provide 2 active arms with a composite gage factor in excess of 200. The temperature-compensated units are corrected for apparent strain on specific materials. They are available for families of materials such as steel, cast iron, copper, brass, etc. Resistance is 70 and 120 ohms.

Kulite-Bytrex Corp., Dept. ED, 50 Hunt St., Newton 58, Mass.

Price: *$90 each.*

Availability: *30 days.*

Test Jack 652

Teflon-insulated

This Teflon-insulated test jack, the Type SKT-37, is designed for use in limited space. The press-fit jack receives a 0.090-in.-diam probe, 0.140 in. long, and has an OD of 0.218 in. above the chassis. Overall height is 0.340; body OD is 0.170 for through-chassis mounting. The contact is of beryllium copper.

Sealectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N. Y.

Electrolytic Capacitor 681

Plug-in type

Model ESS-7515 is an electrolytic capacitor designed especially for printed-board mounting. A plug-in type, cardboard sleeve unit it is an exact replacement for eight original standard 150 wvdc capacitors commonly used in printed circuit radio and TV receivers.

Cornell-Dubilier Electronics Div., Federal Pacific Electric Co., Dept. ED, 333 Hamilton Ave., South Plainfield, N.J.

Price: *$2 ea.*

Availability: *At all Cornell-Dubilier distributors.*

Cooling System 626

Dissipates 10,000 w

This system, designed for cooling radar equipment, uses liquid heat transfer to dissipate heat in capacities to 10,000 w. The system delivers Monsanto Coolanol 45 fluid at a flow rate of 4-1/2 gpm at pressures to 250 psi. The 110-lb unit measures 26 x 20 x 24 in., and operates on 416 v, 400 cps, 3 phase power.

Eastern Industries, Inc., Dept. ED, 100 Skiff St., Hamden 14, Conn.

Integrating Motor-Generator 671

In Size 18

This size 18 motor-generator, the T870-36B, is designed for use in high-accuracy, high-response systems. Temperature-compensated to insure low output sensitivity to varying ambient temperature, the unit features linearity of 0.05% from 0 to 3,600 rpm, and a rotor moment inertia of 10 g per cm^2. Residual position error is 0.006 v, in-phase, and 0.014 v, quadrature; residual axis error is 0.0015 v, in-phase, and 0.002 v, quadrature. Power requirement is 115 v, 400 cps. Output is 2.75 v per 1,000 rpm.

General Precision, Inc., Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N.J.

Availability: *60 to 90 days.*

THE MOST

10MC SOLID-STATE COUNTER-TIMER TSI* Model 365 APTI-METER

FOR THE LEAST

—only $2,650.

bench or rack!

Highest sensitivity. *Three* identical amplifiers — Unique TSI level-sampling design!

●

Greatest Flexibility *Every* counter-timer-frequency function — including programmable function, time-base, and attentuation.

●

Most Compact. Smallest, lightest 10MC package available — coolest-running, too!

Extreme Reliability. *Completely* solid-state design employs "sophisticated simplicity" to reduce semiconductor count, provide wider margins!

●

Ideal Readout. *Seven* in-line NIXIES, no interpretation, no ambiguity — easy on the eyes!

●

Completely Compatible with all standard frequency extenders!

WRITE TODAY FOR COMPLETE SPECIFICATIONS

*Manufacturers of the Ultra-reliable, ultra-popular, solid-state Model 361 Apti-Meter . . . at $1645., the *most* for the *least* at 1MC!

TSI

TRANSISTOR SPECIALTIES INCORPORATED

Sophisticated Digital Instrumentation

TERMINAL DRIVE, PLAINVIEW, NEW YORK • WELLS 5-8700

CIRCLE 49 ON READER-SERVICE CARD

NEW PRODUCTS

Subcarrier Oscillator 639

Displaces 2.1 cu in.

The model VC-42, an LC-type subcarrier oscillator, displaces 2.1 cu in. It is available in all standard instrumentation channels. Silicon transistors are used throughout; ±1% tolerance from calibration curve for a 6-month period is claimed. An internal voltage regulator allows operation from 28 v dc ±10%. Case is cast aluminum.

United ElectroDynamics, Inc., Dept. ED, 200 Allendale Road, Pasadena, Calif.

Delay Line 628

With band pass filter

This dual-function lumped constant delay line and band pass filter has a delay time of 400 μsec, an impedance of 900 ohms, and a bandwidth of 15 kc. The disc-shaped device has a diameter of 4-1/2 in. and is 5/8 in. thick. It weighs 10 oz and has an insertion loss of 8 db at 15 kc. It is encapsulated in epoxy resin.

Nytronics, Inc., Essex Electronics Div., Dept. ED, 550 Springfield Ave., Berkeley Heights, N.J.

Coaxial Transfer Switch 688

Is remotely operated

Type 6720 is a 3-1/8 in., 50-ohm coaxial transfer switch. It automatically switches pairs of 3-1/8 in. transmission lines in less than 2 sec. Operation is by remote control. It can be mounted in any position and supported by the coaxial line if necessary. Frequency range is 0 to 500 mc with a vswr of less than 1.05.

Andrew Corp., Dept. ED, P.O. Box 807, Chicago 42, Ill.

Price: *$1,000 ea, manual; $1,200 ea, automatic.*
Availability: *From stock.*

Time-Encoder Set 612

For multiple data systems

Time correlation of simultaneous recording processes at up to 10 separate locations, at an accuracy of ±1 sec per day, is provided by the ETS-1 electronic timing set. Using a temperature-controlled crystal oscillator, the set provides timing marker pulses at 0.0001-sec to 1.0 sec intervals, followed by a 20-bit real time signal every second. It is built to both military and commercial specifications, and can be packaged for airborne applications. Nixie digital readout is provided.

The Hallicrafters Co., Dept. ED, 4401 W. 5th Ave., Chicago 25, Ill.

Polystyrene Capacitor 609

Has high stability

Ratings on dielectric strength, pf, temperature coefficient and life test are called outstanding for these polystyrene dielectric capacitors. The Type RH is available in hermetically sealed metal cases with glass-to-metal solder-sealed terminals and hermetically sealed rectangular cases. Standard tolerance is ±5% with closer tolerances available. Voltage ratings are 100, 200, 400 and 600 v dc; capacitance values range from 0.1 μf to 10.0 μf.

Efcon, Inc., Dept. ED, Patterson Place, Roosevelt Field, Garden City, L. I., N. Y.

Data Transmitter 605

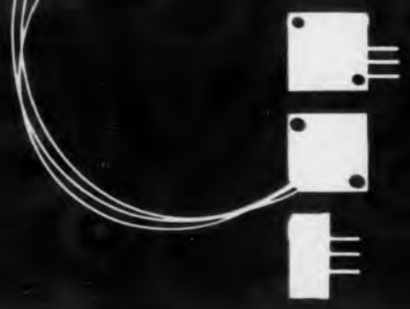
Uses telephone lines

This data transmission system, called the Dial-o-verter, can send as many as 27,000 alphanumeric characters during a 3-min phone call. Terminal equipment is available for use with paper tape, punched cards, and magnetic tape. Extensive error-checking facilities are included. Either transmitter or receiver can be operated on an unattended basis.

Digitronics Corp., Dept. ED, 10 E. 40th St., New York 16, N. Y.

CIRCLE 51 ON READER-SERVICE CARD ➤

SQUARETRIM



FIVE YEARS OF PROVEN TRIMMER PERFORMANCE

THE ONLY SQUARE TRIMMING POTS WITH OVER 2,000,000 UNITS DELIVERED

Daystrom SQUARETRIM potentiometers may look like the many square configuration copies which have been flooding the industry in recent weeks, but they are different. This difference is in their outstanding performance, reliability and broad-line availability. Daystrom has had five years to develop, produce and field-prove the features of the SQUARETRIM potentiometers, so whatever features are important to your application, you can be sure that there is a Daystrom SQUARETRIM to meet your most exacting requirements.

The proof that Daystrom delivers what it promises can be found in over 2,000,000 Daystrom SQUARETRIM's which have been placed into customer operation since 1955. It costs no more to be sure, so when you are ready to order trimming potentiometers, contact your nearest Daystrom Representative or Distributor for immediate delivery. Or you may write the factory direct for Data File ED-1350-2.

DAYSTROM, INCORPORATED
POTENTIOMETER DIVISION
Archbald, Pennsylvania • CAnal 6-3300 (New York, N.Y.)

THERE ARE MORE DAYSTROM SQUARETRIM's IN THE FIELD TODAY THAN ALL OTHER SQUARE TRIMMING POTS COMBINED

Here's why...

Because engineers want to be sure of the basic design, more of them look to the originator of the square-shaped trimmers. They look to Daystrom when specifying this kind of potentiometer.

Because they want to be sure of performance and reliability, more designers look to Daystrom for their SQUARETRIM's. They know they can trust Daystrom specs. They appreciate the conservative ratings, and they have full confidence in the greater safety margin that such ratings afford. And they can be sure that Daystrom SQUARETRIM's will go on meeting application requirements with the same high reliability that has been proven by the 2,000,000 units that have seen field service over the past five years.

Because engineers want to be sure of availability, they like the convenience of doing business with two complete factory sales and stocking offices—one on each coast. They know that from these two factory offices and Daystrom's 23 representatives and many stocking distributors from coast to coast, they can expect to obtain the exact SQUARETRIM's to meet their needs. They know they are selecting from the broadest line of square-shaped trimming potentiometers available today when they specify the Daystrom SQUARETRIM line.

That is why more knowledgeable designers looking for trimming potentiometers specify Daystrom SQUARETRIM—they want the best...and the best is easiest to get.

For more information or a complete file listing the entire SQUARETRIM *line, contact your nearest Daystrom Representative or Distributor, or write the factory direct. Ask for Data File ED 1179-2.*

DAYSTROM
POTENTIOMETER DIVISION
ARCHBALD, PENNSYLVANIA
CIRCLE 52 ON READER-SERVICE CARD

◀ CIRCLE 53 ON READER-SERVICE CARD

NEW PRODUCTS

Force Meters 694

With 2% accuracy

Standard models of Sidco force meters can measure tensional, torsional, or compressive forces up to 20,000 lb with ±2% accuracy. Applications include weighing, torque measurements, remote measuring under hazardous conditions, and load monitoring on equipment and structures.

Plastic Applicators, Inc., Plastronics Div., Dept. ED, P.O. Box 7631, Houston 7, Texas.
Price: *$425 or $695 ea.*
Availability: *From stock.*

Digital Computer 627

With 4-way processing

An asynchronous feature of the Model 212 computer permits simultaneous processing of 4 instructions, resulting in better use of memory, faster running time and reduced programming time. The general-purpose, simplified unit can multiply 2 48-bit words in less than 10 μsec, including access times. Maximum access time for a pair of instructions is 1 μsec.

Philco Corp., Computer Div., Dept. ED, Tioga and C Streets, Philadelphia 34, Pa.

DC Power Supply 680

Transistorized

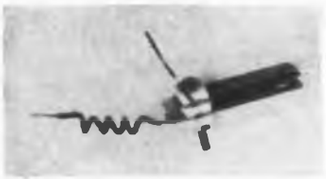
Type SCRT transistorized power supply has an output of 0 to 60 v dc at 0 to 7.5 amp. Dynamic response is less than 200-mv transient spike for 100 μsec for a ±1-amp step change in load current and less than 1-v transient spike from 7.5 to 0 amp. Ripple is less than 3 mv rms. The unit has internal and remote sensing and a floating output.

Del Electronics Corp., Dept. ED, 521 Homestead Ave., Mount Vernon, N.Y.
Price: *$690.*
Availability: *Stock to four weeks.*

NEW PRODUCTS

Thermal Relay 675

Is open type



Model BR-101 thermal relay is of open-type construction. The contacts can be set to break the circuit when a surge in current exists. Contact closure is of the slow make-or-break type. Contact rating is 3 amp resistive, 115 v ac, with a minimum of 100,000 operations. The units will operate on ac or dc, power drain is 2 w. Voltages available are 2 to 115 v ac or dc.

Clairtron Manufacturing Co., Dept. ED, P.O. Box 171, Orange, N.J.

Price: *From $0.65 to $1.25, depending on quantity.*

Vapor Pressure Thermometer 623

For low temperatures

This vapor pressure thermometer, for high-accuracy determination of temperatures over small spans in the low-temperature regions, has a gas-filled, sealed sensing element. There are 7 small ranges between 2 and 150 K. Response time is better than 20 msec. Excitation is 5 v, ac or dc; carrier frequency is 0 to 20 kc. Output is 20 mv nominal full scale.

Cyrogenics, Inc., Dept. ED, 1129 Vermont Ave., N.W., Washington 5, D.C.

Wirewound Potentiometer 676

Ratings to 2-1/2 w

Series 3200 multi-turn, precision, wirewound potentiometers are available in 3-, 5-, and 10-turn models. Power ratings are to 2-1/2 w. Modification of basic units to special requirements is possible, such as the addition of 46 extra taps on 10-turn models, three-ganged sections, and special resistance characteristics.

Duncan Electronics, Dept. ED, 1305 Wakeham Ave., Santa Ana, Calif.

Price: *From $16 to $25.*

Availability: *Immediate delivery.*

MODEL NO.	FREQ. (KMC)	AVE. PWR. (WATTS)	MAX. INS. LOSS (db)	MIN. ISOLATION (db)	MAX. INPUT VSWR	DIMENSIONS (INCHES) DIA.	HEIGHT	WEIGHT LBS. OZ.
D52J1	.40- .45	25	.7	17	1.30	5 7/16	7/8	3
D52P1	.30- .36	15	0.7	20	1.30	2 1/2	3 11/16	3 10
D52L1	1.25- 1.35	10	0.7	20	1.30	2 1/2	3 11/16	3 10
D52S1	2.7 - 2.9	10	0.5	20	1.30	1 5/8	2 1/16	12
D52C1	5.4 - 5.9	15	0.3	20-30	1.30	1 2/5	1 2/5	6
D52C1-2	5.4 - 5.9	15	0.5	20-30	1.30	1 1/2	3/4	4

* Physical dimensions on the D52D1, L1 and S1 subject to change in the near future. This change, if made, will be aimed at improving manufacture of the units plus improving reproducibility.

Sperry's constant effort to reduce the size and weight of its devices without sacrificing any of their desirable features or performance characteristics has resulted in a complete line of coaxial and strip transmission line isolators and circulators miniaturized to a degree that only Sperry research could have made possible.

These isolators and circulators have no external permanent magnets, possess excellent electrical performance and almost perfect magnetic shielding. Designed for operation from 225 mc to 6000 mc with 10 percent bandwidths. Miniaturized units with wider bandwidths and stable operation under rigid environmental conditions are available on special order.

Sample units available from stock. We will welcome your inquiries for more complete information.

MODEL NO.	FREQ. (KMC)	AVE. PWR. (WATTS)	MAX. INS. LOSS (db)	MIN. ISOLATION (db)	MAX. INPUT VSWR	LENGTH* (INCHES)	WEIGHT (OZ.)
D44L7	1.25 - 1.35	5	0.9	15	1.20	6 30/64	6¼
D44L7-7	1.24 - 1.40	5	0.8	12	1.20	6 30/64	6¼
D44L7-6	1.435- 1.535	5	0.6	16	1.15	6 30/64	6¼
D44L11-2	.96 - 1.215	10	0.8	10	1.20	11 11/16	10
D44L33-25	1.7 - 2.3	10	1.0	13	1.20	10	8
D44L33-5	2.0 - 2.7	10	2.0	40	1.20	11 55/64	14
D44S7	2.7 - 3.1	5	0.9	15	1.20	4 11/32	5
D44C7	5.4 - 5.9	5	0.9	15	1.20	4 11/32	5

*All units have a maximum diameter of 25/32 inch.

CIRCLE 55 ON READER-SERVICE CARD

Precise Angle Indicator 670

Accurate to ±6 min

The CO 2721011 precise angle indicator has an accuracy of ±6 min; repeatability is ±1.2 min. Sensitivity is 1.0 min, and slewing speed is 7 sec for 180 deg. It is available with a single or dual sensor and an auxiliary re-transmitter. Input power is 30 va; single source power requirement is 115 v, 400 cps, 1 phase. The 4-lb unit is 1-3/4 x 9-1/2 x 9-1/8 in.

General Precision, Inc., Kearfott Div., Dept. ED, 1150 McBride Ave., Little Falls, N.J.
Price: *$1,075.*
Availability: *30 days.*

Programing Chassis 625

For data system controls

Voltage level or contact closure inputs in any code form may be re-coded, serialized and sequenced to output devices by the PC-150 programer. The rack-mounting chassis uses modular construction and readily-accessible plugboards. It may be used as a system controller, initiating commands and providing contact closures for control of external equipment. Six standard modules are available.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

Tantalum Capacitors 640

Non-polar for ac circuits

The Series N non-polar solid tantalum capacitors, developed for ac circuits, are made up of 2 identical capacitors connected back-to-back and placed in a rigid plastic sleeve. Values range from 0.16 to 160 μf in working voltages of 6 to 50 v for continuous operation at 85 C.

Union Carbide Corp., Kemet Co., Dept. ED. 11901 Madison Ave., Cleveland 1, Ohio.
Price: *$1.79 to $6.79 per 1,000.*
Availability: *1-week delivery.*

still waiting for your pots?

Are your pot delivery schedules figured in weeks instead of days? If you're a member of the Pot Waiter's Club, read on:

At ACE, we fully inventory *all* parts for our complete standard line! And when a pot *has* to be made from scratch — we cut time there, too. All raw materials are warehoused, and a complete machine shop, including Swiss screw machines, is maintained. Our special prototyping department lops the time off special requirements.

Prepared engineering releases and part prints for standard pots await your incoming order. That's why, within hours after receipt, your order for standards is into manufacturing! So specify from Ace's comprehensive line of standards, in full resistance ranges, sizes, configurations and functions. Your "special spec" is probably among our standard line — and that means time and money saved for you!

This 1-1/16" ACEPOT®, typifying the entire standard line, is available on prompt delivery!

ACE ELECTRONICS ASSOCIATES, INC.
99 Dover Street, Somerville 44, Mass.
SOmerset 6-5130 TMX SMVL 181 West. Union WUX

Acepot® Acetrim* Acecal® Acechm® *Reg. Appl. for

CIRCLE 56 ON READER-SERVICE CARD

NEW PRODUCTS

Portable Oven 657

1 cu ft capacity

This portable oven has almost 1 cu ft of inside space. It is designed for general utility heating and drying jobs to 500 F. A combination pilot light and thermostat controls the heavy-duty elements. Top and front lift in one hinged unit.

Planchets, Dept. ED, Chelsea, Mich.

IF Amplifiers 665

Subminiature, logarithmic type

The LIFV series if amplifiers have center frequencies of 30, 60, and 90 mc with logarithmic response. They have a low noise figure, large dynamic range, and high gain. Special input trimmer control permits matching over a wide range.

The W. L. Maxson Corp., Dept. ED, 475 10th Ave., New York 18, N. Y.

Magnetic Shield 658

For levitated gyro

The Netic Co-Netic shield is designed to divert extraneous low-level magnetic fields from the levitated rotor of the Nordsieck electric vacuum gyro. The series of isolated shields has cable entries surrounded by extended tubulations; labyrinth paths are provided for the cables. The shields are neither retentive nor sensitive to shock, and require no periodic annealing.

Perfection Mica Co., Magnetic Shield Div., Dept. ED, 1322 N. Elston Ave., Chicago 22, Ill.

Miniature Solenoids 616

1/4 to 1/2 in. OD

These miniature solenoids are made with diameters of 1/4, 5/16 and 1/2 in. Voltages are 6, 12, 24, 36, 115, and 230 v dc. Power ratings begin at 1/4 w. All requirements of MIL-S-4040C are met.

Cannon Electric Co., Dept. ED, 3208 Humboldt St., Los Angeles 31.

Static Inverter 614

Supplies 250 va

Developed for a military application, the W-1502 static inverter supplies 250 va of 60 cps power. Input is 23 to 28 v dc; output is 115 v ac ±3%. The input synchronizing signal is 1/4 v rms, 55 to 65 cps. The rack-mounting unit is virtually silent in operation. Ambient temperature range is —50 to 55 C.

Electrosolids Corp., Dept. ED, 6352 Bellingham Ave., North Hollywood, Calif.

High-Purity Indium 618

99.999+% pure

This semiconductor grade indium, 99.999+% pure, contains less than 1 ppm of either silver or copper. Tin and lead content is less than 3 ppm each. Other elements are not detected by spectrographic analysis.

Alpha Metals, Inc., Dept. ED, 56 Water St., Jersey City 4, N.J.

Tubular Capacitors 613

Mylar dielectric

This series of aluminum foil and Mylar dielectric capacitors has 100, 200, 300, 400 and 600 v ratings. Temperature range is —55 to 125 C. The 100 v units have values from 0.015 to 0.680 μf; in 600 v, values range from 0.001 to 0.100 μf. Sizes begin at 0.188 in. diameter by 0.750 long. Tolerances from ±1% to ±20% are available.

Faradyne Electronics Corp., Capacitor Div., Dept. ED, 471 Cortlandt St., Belleville, N. J.

CIRCLE 58 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Silicon Rectifiers 641

20 amps at 150 C

These stud-mounted rectifiers are capable of delivering 20 amp at 150 C in half-wave circuits. The double-diffused silicon junction units, designed for power rectifier and magamp use, are designated Series MO. The units are rated at 50 to 800 PIV, and can deliver up up to 60 amp in full-wave circuits.

Trans-Sil Corp., Dept. ED, 55 Honeck St., Englewood, N. J.
Availability: *Immediate, from stock.*

Brush Block Assemblies 631

For use with slip rings

This line of brush block assemblies is made for use with slip ring assemblies in gyros, synchos and resolvers, and with printed circuit commutators. They are molded in diallyl, nylon, and epoxy resins using single or multiple strand spring temper gold alloy wire. Contacts are designed for minimum bounce and noise under conditions of high speed and vibration. Life expectancy is in excess of 5×10^7 cycles.

Airflyte Electronics Co., Dept. ED, 535 Ave. A, Bayonne, N.J.

Coaxial Connector 656

With anti-galling lubricant

Elimination of galling on bullet-type inner conductor connector contact surfaces is claimed for the Prodelube #8 lubricated coaxial-transmission-line-anchor insulator connector. The adherent lubricant, a high-temperature metallic formulation, protects against galling.

Prodelin, Inc., Dept. ED, 307 Bergen Ave., Kearny, N. J.
Price: *On request.*
Availability: *Immediate.*

ELECTRON TUBE NEWS
...from SYLVANIA

3 new Gold Brand types
expand industry's widest line of
26.5V SUBMINIATURE TUBES

Sylvania Gold Brand 26.5 Volt Subminiature Tubes afford dramatic opportunities for improved design of compact, reliable communications, telemetering and guidance equipment using a 26.5 volt energy source. Now, the Sylvania premium subminiature tube line includes 3 new types *featuring:* New Rugged-Design 26.5V Heater • High Uniformity, Stability • Shock Resistance to 750g • Thermal Resistance to 220°C • Intense Radiation Resistance *and offering:* Compact Equipment Design • Significant Circuit Economies • Improved Equipment Reliability.

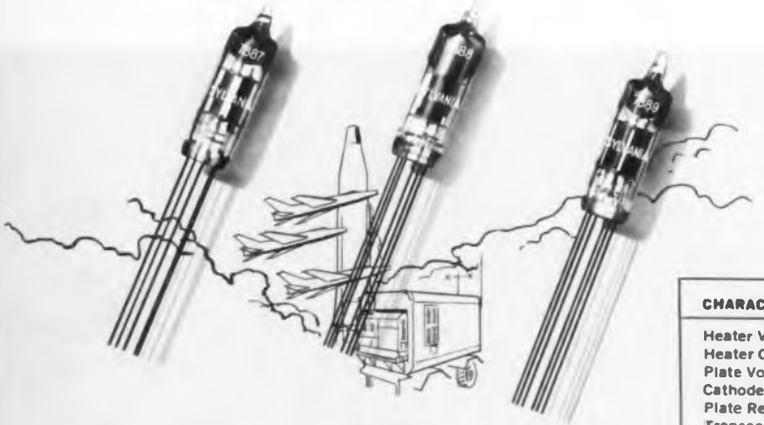
At the heart of each Gold Brand Tube is a remarkable advance in 26.5 volt heater design. This new Sylvania design makes practicable quantity-produced heaters with low heater-power requirements and high mechanical strength. The heater base is a heavy support rod (mandrel) coated with a high-temperature insulator. Extremely fine heater-wire is wound over the base, and the entire assembly recoated to form an efficient folded coil heater. In addition to utilizing the new heater design for 26.5 volt *heater* operation, five Gold Brand subminiature types operate with a B-supply of 26.5 volts, making them ideally suited for hybrid designs.

Sylvania 26.5 volt subminiature tubes simplify circuitry and reduce or eliminate components ordinarily required for the conversion of the "natural" supply voltage. Series string and associated problems can be eliminated. Too, inherent tube resiliency to plate and screen voltage surges eliminates the need for compensating circuits. Result: enhanced equipment reliability, significant cost reductions.

New, Improved Specifications assure uniform, reliable, high-performance tubes capable of withstanding impact acceleration tests of 750g, fatigue tests of 2.5g and ambient bulb temperatures of 220°C. All Sylvania Gold Brand Subminiature Tubes are rigidly disciplined by tighter controls on lot variables, improved AQLs and increased test requirements. As an example, plate current and Gm must meet an AQL of 0.4%. Life tests for 100, 500 and 1000 hours provide a quantitative determination of end-points such as shorts, heater current, plate current, Gm, insulation resistance, interface impedance. Further, Gold Brand subminiature types are capable of withstanding radiation dose rates (fast neutrons) of 10^{12}NV and accumulated radiation of 10^{16}NVT.

Specify Sylvania Gold Brand Subminiature Tubes. Other Gold Brand types that can be designed with the Sylvania 26.5 volt heater include prototypes: 5719, 5899, 5977, 6205 and 6206. Learn more about the advantages of Sylvania subminiature types for your critical design from your Sylvania Sales Engineer.

For data on specific types, write for the FREE 84-page Gold Brand 26.5 Volt Subminiature Tubes Booklet to Electronic Tubes Division, Sylvania Electric Products Inc., Dept. M, 1100 Main Street, Buffalo 9, N. Y.



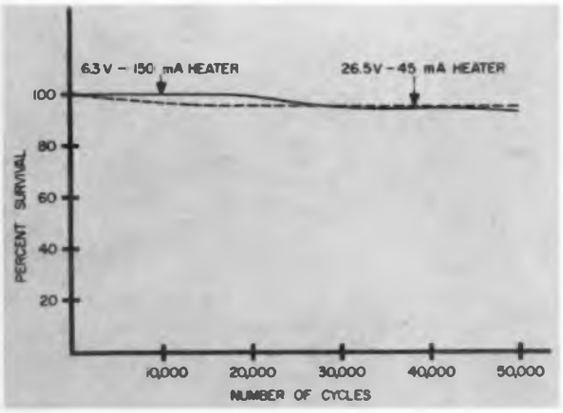
SYLVANIA—7887. Medium-mu double triode; 26.5V, 90mA heater with 100V Eb; designed for oscillator, amplifier and low-power servo circuits.

SYLVANIA—7888. High Gm, medium-mu triode; 26.5V, 45mA heater with 100V Eb; designed for use as a UHF oscillator as well as low-frequency oscillator and amplifier applications.

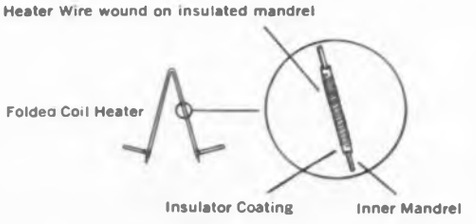
SYLVANIA—7889. High-mu double triode; 26.5V, 45mA heater with 100V Eb; intended for low level audio circuits.

CHARACTERISTICS	7887*	7888	7889*	UNITS
Heater Voltage	26.5	26.5	26.5	V
Heater Current	90	45	45	mA
Plate Voltage	100	100	100	Vdc
Cathode Resistor	220	150	1500	Ohms
Plate Resistance	4000	–	–	Ohms
Transconductance	5000	5800	1800	μmhos
Amplification Factor	20	27	70	–
Plate Current	8.5	8.5	0.8	mAdc
Grid Voltage				
Ib = 100 μAdc Max.	−9	−7	–	Vdc
Ib = 50 μAdc Max.	–	–	−2.8	Vdc

*Each Section



Typical test results for the Sylvania 26.5 volt heater compare very favorably with a 6.3 volt heater of known high reliability. Testing for both types was performed at 120% of rated heater voltage.



Sketch shows enlarged view of new Sylvania 26.5V heater.

SYLVANIA

N-9171-3

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

Sonic-Delay Line 621

Has long delay of 0.1 sec

Model FA-573 sonic delay-line has a long delay of 0.1 sec. Attenuation is 20 db at 300 cps and impedance is 1 K. The unit has multiple taps every 1 msec and has 100 taps with an accuracy of better than 0.5%. Cut-off frequency is 400 cps and phase linearity is better than 0.75% up to 300 cps. The unit measures 10 x 19 x 21 in. and weighs 200 lb.

Control Electronics Co., Inc., Dept. ED, 10 Stepar Place, Huntington Station, L.I., N.Y.
Availability: *Six to eight weeks.*

Polyester Rods 417

Made of fiberglass-reinforced polyester, these rods can be used in applications requiring insulation of structural, mechanical or spacing members. Arc resistance is 150 sec per ASTM D-495 and moisture absorption is 0.4% max. It is furnished in 8-ft lengths.

Glastic Corp., Dept. ED, 4321 Glenridge Road, Cleveland 21, Ohio.
Price: *6 cents to 25 cents per ft.*

Punched-Card Switch 606

Contains 72 separate switches

This multiple punched-card switch has a capacity of 72 switches. After the card is inserted and the push-to-close button is pushed, the punched holes have closed switches and the unpunched holes have open switches. Each side of each switch is isolated and tapered to accept Taper Tab receptacles. Weight of the switch is 3 lb, 3 oz. It measures 3-5/16 x 5 x 4-1/2 in.

Taurus Corp., Dept. ED, 8 Coryell St., Lambertville, N.J.
Price: $285.
Availability: *Immediate.*

NEW PRODUCTS

Analog-To-Voltage Converter 407

Completely solid state

The Magaverter is a completely solid state, precision analog voltage to frequency converter that produces an output square wave whose frequency is directly proportional to the input voltage. It maintains an input-output linearity of ±1/4%. Eight standard models provide full scale output frequencies of from 30 cps to 25,000 cps and input voltage ranges of 0 to 1, 0 to 10, and 0 to 100 v.

Pioneer Magnetics Inc., Dept. ED, 850 Pico Blvd., Santa Monica, Calif.

Instrument Rectifiers 408

Series 160-U, offered in selenium copper oxide, has all-metal structure, dual-mounting holes, choice of wire or filiform leads, and a selection of finishes. Units are color-coded.

Conant Laboratories, Dept. ED, Box 3997, Bethany Station, Lincoln, Nebr.

Induction Motor 557

For 20-in. fan

Type DE-30-14 induction motor is designed to drive a 20-in. fan in military ground-support equipment, but can be adapted to other applications. Specifications include: 0.325 hp; speed, 5,600 or 1,725 rpm; voltage, 208 v at 400 cps, three-phase. The unit is made for continuous duty and weighs 12 lb, 4 oz. It meets MIL-M-7969, MIL-E-5272, MIL-STD-105, MIL-T-1193 and other specs.

Kearfott Div., General Precision, Inc., Dept. ED, 1150 McBride Ave., Little Falls, N.J.

Battery Substitute 440

Replaces 1.5-v dry cells

The potentiometer battery substitute is offered for strip-chart recorders, laboratory measuring potentiometers, and other applications requiring a constant dc voltage supply. It can replace 1.5-v dry cells, standard cells, and standardizing mechanisms in strip-chart recorders of all types. It operates on 117 v ac ±20% and delivers a constant voltage to the measuring circuit bridge. Temperature coefficient can be ±0.004% or 0.0006% per deg F. Output voltage stability is better than ±0.04% for an input variation of ±20%. Dimensions are 2.5 x 2.5 x 3.25 in.

Dynage, Inc., Dept. ED, 75 Laurel St., Hartford, Conn.

Availability: Three to four weeks.

Connector 409

Series SRE has a contact pin 0.003-in. in diameter. The molding material is glass-filled diallyl phthalate. The design used eliminates the need for connector disassembly when using a hood.

Winchester Electronics Inc., Dept. ED, Willard Road, Norwalk, Conn.

Snap Switch 607

Has 3/8-in. over-travel

This snap switch has a plunger travel of 1/2 in. and over-travel of 3/8 in. Both spdt and spst types are available with a snap-in bezel for front mounting or threaded bushing for back mounting. Heavy-duty construction and coin-silver contacts are employed. The UL approved rating is 10 amp at 125 v ac or 5 amp at 250 v ac.

Ucinite Co., Div. of United-Carr Fastener Corp., Dept. ED, Newtonville 60, Mass.

***Availability:** Samples, immediate; production quantities by Jan. 1, 1961.*

NEW PRODUCTS

DC-To-DC Converter 447

This subminiature, high-voltage, dc-to-dc converter provides 12 kv dc or 16 kv dc for 250 hr from a single 0.8 amp-hr, 1.3-v mercury cell. Hermetically sealed in a steel housing, it is 2.437-in. long by 1-in. sq. Also available in a 1-in. diameter cylindrical case. Telex Special Products Division, Telex, Inc., Dept. ED, 1633 Eustis St., St. Paul, Minn.

Angular Divider 448

Gimbal-mounted components such as synchros, resolvers, and microsyns may be indexed with better than 20 sec absolute accuracy and 10 sec repeatability by this angular divider. Theta Instrument Corp., Dept. ED, 520 Victor St., Saddle Brook, N.J.

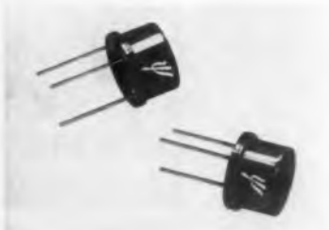
Price: *$2,000*

Availability: *Delivery from stock.*

Pancake Resolver 449

This pancake resolver has a functional accuracy of 10 sec of arc and a repeatability of 2 sec. Of integral bearing design, it is available in beryllium or aluminum housings. Components Marketing Div., Reeves Instrument Corp., Dept. ED, Garden City, N.Y.

Availability: *75 to 120 days in prototype quantities.*



Switching Transistor 451

This general purpose switching transistor, type 2N1837, has nearly half the collector to emitter voltage drop of the similar type 2N697. The triple-diffused mesa transistor has 3 times the small signal beta, half the collector capacitance, and half the leakage current of the 2N697. Pacific Semiconductors Inc., Dept. ED, 10451 W. Jefferson Blvd., Culver City, Calif.

Test Point Connectors 452

Designed for printed circuit applications, these test point connectors can be located at convenient positions on a printed-circuit board, for easy test take-off points. Single and multiple contact types with 4, 6, 8, 28 and 42 test points are available. Current ratings for all types is 3-amp continuous and 4-amp max. De Jur-Amsco Corp., Electronics Div., Dept. ED, 45-01 Northern Blvd., Long Island City 1, N.Y.

Tape Reader 453

This block tape reader can simultaneously read up to 256 bits of information from a 5- to 8-channel tape. It can handle up to 32 or more lines of coded material. Wang Laboratories, Inc., Dept. ED, 12 Huron Ave., Natick, Mass.
Price: *$1,200 up.*
Availability: *2 to 3 weeks.*

Magnetic Clutch 454

A stationary magnet, ball-bearing mounted, is used in the 5.5 SMR clutch. This unit has a torque rating of 45 ft-lb, and can be converted to a magnetically set brake. Also available in clutch-brake combinations. Stearns Electric Corp., 120 N. Broadway, Milwaukee, Wis.

Servo-Accelerometer 455

Linearity and null stability exceed 0.001 g in the model 302 servo-accelerometer. Signal output is 0.2 ma per g over over a 20± g range at ±5 v dc. The ruggedized, precision unit is 2 in. long and measures 1 in. in diameter. Kistler Instrument Corp., Dept. ED, 15 Webster St., North Tonawanda, N.Y.

Magnetic Clutch 456

This basic direct-acting clutch, the model T502, is designed so that, with the coil de-energized, input and output shafts may rotate independently. Output torque of the 13-oz unit is 40 oz-in. Military environmental specifications are met. Sterling Precision Corp., Instrument Div., Dept. ED, 17 Matinecock Ave., Port Washington, L.I., N.Y.

Unitized Rectifiers 457

These unitized packages of double-diffused silicon rectifiers deliver from 1 to 35 kv at current ratings from 1 to 20 amp. They feature guaranteed division of reverse voltage with optimum transient, steady state, and overload characteristics. Trans-Sil Corp., Dept. ED, 55 Honeck St., Englewood, N.J.
Availability: 2-week delivery from stock.

Average Power Meter 460

Direct measurement of power levels up to 10 mw and accuracy to 3% of full scale reading are features of the model 31A1 average power meter. There are 5 ranges from 0-0.1 to 0-10 mw and 2 ranges 0-10 and 0-15 db. Sperry Microwave Electronics Co., Dept. ED, P.O. Box 1828, Clearwater, Fla.
Price: *$240*
Availability: *Delivery from stock.*

DRAFTING TRENDS

Helpful new booklet suggests drafting, engineering shortcuts

Just published—"DRAFTING SHORTCUTS" is a completely new booklet of helpful ideas and aids for engineers, draftsmen and students. It is well illustrated, clearly and logically written. It contains a wealth of time-saving tips to speed both routine and specialized tasks.

The ideas selected were submitted by professionals and judged by an impartial panel of widely recognized authorities on the various topics covered.

As an example, the section covering *Calculating Ideas* includes a simple means of locating stress points on cantilevered beams, also a simple method for retaining fundamental trigonometric relations.

In the section on *Drafting Shortcuts*, our editors have come up with topics like a simplified, fast and easy method for drawing gear teeth profiles and a rapid means of showing twisted wire elements.

The *Engineering Data* section covers new, easy-to-use shortcuts to formulas and engineering data.

There's a special section devoted to time-saving techniques on the drawing board, too. One of the suggestions on how to make life easier for the draftsman tells how to use a bent paper clip as a variable guide for making section lines.

For your free copy of "Drafting Shortcuts" contact your POST dealer or write today to the Frederick Post Company, 3644 N. Avondale Avenue, Chicago 18, Illinois.

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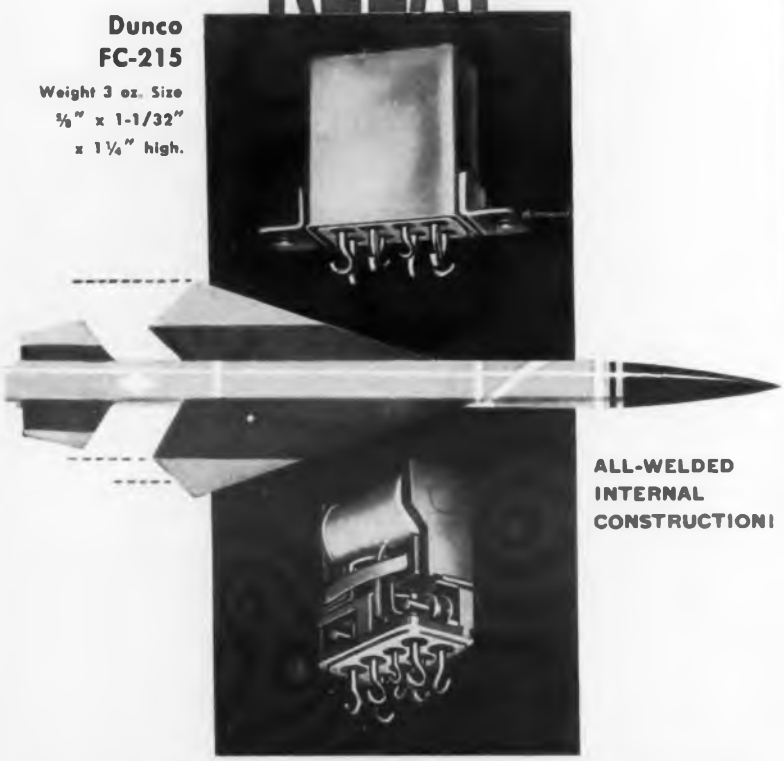
CIRCLE 64 ON READER-SERVICE CARD

NEW! 10-AMPERE RELAY

Dunco FC-215

Weight 3 oz. Size ⅛" x 1-1/32" x 1¼" high.



ALL-WELDED INTERNAL CONSTRUCTION!

for missile and aircraft uses

Conservatively rated for 10 ampere DC operation, these solidly built little DPDT units fill a long standing need for dependable heavy duty power relay service under temperature, vibration and shock extremes.

Constructed throughout to meet or surpass MIL-R-575C and MIL-R-25018 requirements. No internal soldered joints. Withstand 30G vibration to 2000 cycles and 50G shock. Standard coils rated 26.5 Volts DC nominal with 400 ohms coil resistance. Other coils available. Designed for 125° C. operation

Header terminals are 0.2" grid-spaced and can be furnished with hook, long or short wire lead terminals.

WRITE FOR DUNCO BULLETIN FC-215

STRUTHERS-DUNN

World's largest selection of relay types

STRUTHERS-DUNN, Inc., Pitman, N. J.

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CIRCLE 65 ON READER-SERVICE CARD

NEW PRODUCTS

Binary Encoder 459

Position-to-digital

Designed for airborne and missile applications, model 793M shaft position-to-digital encoder is packaged in a size 8 casting, measuring 0.75 in. in diameter and 1.25 in. long. Resolution is 128 counts per revolution; total capacity is 8192 binary counts. Accuracy is never less than the least significant bit in 2^{13} counts. Counting speeds of 0 to 200 rpm are possible.

Librascope Div. of General Precision, Inc., Dept. ED, 808 Western Ave., Glendale 1, Calif.

Knobs 713

Models MS-91522, MS-91523 and MS-91524 knobs are for use on AN/GRC, AN/PRC, AN/TRC and AN/VRC equipment.

Vemaline Products Co., Dept. ED, Franklin Lakes, N.J.

Price: *On request.*
Availability: *From stock.*

Rack and Panel Connector 410

Has 32 Teflon-insulated terminals

Model 32T rack and panel connector with separately insulated Teflon terminals has been tested at temperatures to 200 C and exposed to humidity and salt spray. Under these conditions, it shows low losses, even when subjected to high-power, high-frequency and high-voltage handling capabilities. It is suitable for use in missile, avionic and ground-support equipment as well as in reliability test-lab applications.

Jupiter Electronics, Inc., Dept. ED, 225 E. 144th St., New York 51, N. Y.

Constant-Voltage Transformer 632

For low-voltage applications

The CVO transformers are claimed to be the first devices of their class to exhibit constant-voltage outputs for low-voltage applications such as milling, grinding and electrical machinery controls. Outputs are 10, 12, 14, 16 and 18 v. Output variation does not exceed ±1.5%. Rated input is 90 to 130 v.

Nytronics, Inc., Essex Electronics Div., Dept. ED, 550 Springfield Ave., Berkeley Heights, N.J. ***Availability:*** *From stock.*

Cable Connectors 411

This line includes electrical plugs, cable connectors, receptacles and distribution blocks for both single and multiple conductor cable, covering wire sizes 18 through 750 MCM cables.

Empire Products, Inc., Cam-Lok Div., Dept. ED, P.O. Box 98, Cincinnati 36, Ohio.

Tube Carriers 622

Made of glass ceramic

These chemically machined glass ceramic boards transport 154 electron tubes through an automatic conveyor tester. Two patterns are currently used, one with nine contact areas and one with seven. Each area contains a 0.05-in. hole and two precisely-positioned slots measuring 0.2 x 0.195 in. Boards measuring 2.25 x 6 in. also contain 0.047-in. holes in circuit runs and 0.148-in. holes for socket pins.

Corning Glass Works, Dept. ED, Corning, N. Y.

Availability: *Made on order to meet customer specs.*

NEW PRODUCTS

Solid-State Flasher Control 555

For critical circuit requirements

Model 1500 solid-state flasher control is for critical circuit requirements and performance. It operates from 18 to 32 v dc. Peak-to-peak ripple is up to 10 v +70 v transient. The control is available from 2 sec per cycle down to 0.05 sec per cycle. Duty cycle is from 1:4 up to 4:1. Temperature range is −52 to +72 C. Timing is 20% accurate over temperature and voltage range. Switch is spst type.

Spec-Technology, Inc., Dept. ED, 13901 Saticoy St., Van Nuys, Calif.

Miniature Capacitors 642

Range is 0.001 to 1 μf

Having a capacitance range of 0.001 to 1 μf, these subminiature 50- and 100-v capacitors are for transistor circuitry. Lightweight and compact, the units have a capacitance tolerance of ±10%. A tolerance of ±5% can be furnished. Requirements of MIL-C-14157B and MIL-C-26244 are met.

Dearborn Electronic Laboratories, Inc., Dept. ED, 1421 N. Wells St., Chicago 10, Ill.

Miniature Feed-Through Terminal 509

No. 3FT3 feed through terminal secures directly to panel assemblies by means of an integrally molded threaded body. The threads are 1/4 in., 24 NS-2A. The tin-plated brass rod of the terminal conforms to QQ-B-626 and HP4-14.

Whitso, Inc., Dept. ED, E1-2 Byron St., Schiller Park, Ill.

Subminiature Trimmer Potentiometer 504

Model 540 trimmer potentiometer operates to 200 C. The 2-w unit stands 50 g vibration and 100 g shock and acceleration.

Handley, Inc., Dept. ED, 12960 Panama St., Los Angeles 66, Calif.

Price: *From $5.37.*

Availability: *From stock.*

Heavy-Duty Switches 563

Handle 20 amp or 2 hp

The 2HL series of snap-acting, precision switches comes in a basic form with a variety of leaf, hinged lever and plunger actuators and with solder-lug, screw type or snap-on terminals. The switches are listed by UL for spdt operation at 2 hp, 250 v ac; 1 hp, 125 v ac; 20 amp, 125 v ac. The basic unit is 11/16-in. wide, 1-15/16-in. long and 13/16-in. high.

Unimax Switch Div., The W. L. Maxson Corp., Dept. ED, Ives Road, Wallingford, Conn.

Price: *$1.83 to $3.78.*

Availability: *Four to five weeks.*

Mica Window Image Tube 412

Type FW-109 is similar to the 6411 image tube but has an exit face plate which carries a phosphor screen. The exit window is hermetically sealed to the anode terminal and tube body.

ITT Laboratories, Components and Instrumentation Laboratory, Dept. ED, Fort Wayne, Ind.

Price & Availability: *$875; 60 days.*

Spot Particle Resolver 567

For quality control applications

The flying-spot particle resolver is for applications in industrial research and quality control. It is constructed in console form and is used to produce a picture of a microscopic object on a cathode-ray tube. It provides magnification of up to 8,000 diameters, 700-line definitions and a resolution of 0.0001 cm.

Instrument Corp. of America, Dept. ED, 1545 Kennewick Road, Baltimore 18, Md.

Price: *$22,000.*

Availability: *60 days.*

CRT OF THE MONTH

New! ETC Type 31SBP — *for transistorized scopes. Designed and produced by ETC to MIL-E-1D specifications, this 3¼" by 2¾" flat face tube combines very low deflection factors with excellent light output at modest voltages. Length is only 13½". A linear post accelerator and geometry adjust electrode minimize pattern distortion.*

Deflection Factors:
D1 & D2 .....25.0 to 30.0 v dc/in.
D3 & D4 .....12.5 to 15.5 v dc/in.
Post Accelerator Voltage: .....3000 v dc.

pacing trends

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Over 50 standard types . . . many specials . . . produced for oscilloscopes and critical display instrumentation. 1 to 10 guns; square, round, or rectangular faces; high resolution; spiral band for radar, fire control, counter-measures, guidance—where quality control counts most. Submit your application details for an engineering review.

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CIRCLE 69 ON READER-SERVICE CARD

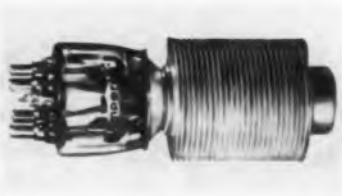
NEW PRODUCTS

DC Power Supply 461

The high-voltage power supply model N-4035 provides up to 3,500 v at 25 ma, positive or negative output, and a line and load regulation of 0.005%. Ripple is less than 5 mv rms. Panel height of the rack-mounted unit is 5-1/4 in. Hamner Electronics Co., Inc., Dept. ED, P.O. Box 531, Princeton, N.J.

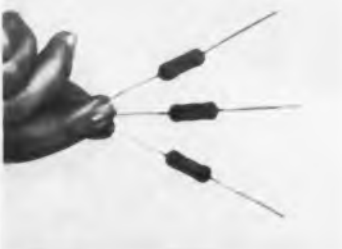
Clutch-Brake 462

A differentially coupled pair of clutches with an integral, anti-backlash brake, model 201-100-1 features stainless-steel design. Molybdenum disulphide impregnated bearings are used. Input shaft diameter is 0.375 in., output shaft 0.187 in., wound for 24- to 28-v dc supply. Marketing Computers, Inc., 50 St. Benedict, Florissant, Mo.



Constant Power Triode 463

An external-plate constant power triode, the forced air cooled type 7753 has a 2,100-w plate dissipation rating. It is designed for use as an oscillator up to 50 mc. Power output is said to remain relatively constant despite load impedance variations. Amperex Electronic Corp., Power Tube Div., Dept. ED, 230 Duffy Ave., Hicksville, N.Y.



Half-Watt Resistor 464

These epoxy-coated precision film resistors, the N-70 line, cover a range of 10 ohms to 1 meg. Typical resistance change under moisture testing is said to be less than 1 per cent. Corning Glass Works, Dept. ED, Corning, N.Y.

Price: *On request.*

Availability: *Immediately, from stock.*

Junction Block 465

Crimp-type cable connections are used on this junction block, designed for tapping runs of subminiature coaxial cable. Optimum electrical characteristics are maintained in the main cable and tap cable runs. Sealectro Corp., Dept. ED, 610 Fayette Ave., Mamaroneck, N.Y.

Reference Standard 466

This portable ac-dc reference source can be used for voltmeter calibration, as a power source up to 10 w, and as a 0-100-v ac-dc voltmeter. Accuracy is ±0.20 to 0.25% in the model 5890. Commercial Products Div., Tensor Electric Development Co., Inc., Dept. ED, 1873 Eastern Parkway, Brooklyn 33, N.Y.

Price: *$495*

Availability: *2 to 3 weeks.*

Perforated Tape Handler 467

Forward or reverse reading of perforated tape at speeds up to 400 characters per sec, and rapid rewind at speeds up to 1,000 characters per sec, are possible with model 4566 tape handler. Measuring 10-1/2-in. in height and 19-in. in width, it is designed for use with the firm's 3500 and B3500 tape readers. Digitronics Corp., Dept. ED, Albertson Ave., Albertson, Long Island, N.Y.

Miniature Circuit Breaker 468

Capable of interrupting up to 5,000% of its rated capacity, the 2100 series 50-amp circuit breaker was designed for aircraft applications. It is not sensitive to vibration or humidity, and resists sand, dust, and corrosion. Wood Electric Corp., Dept. ED, 244 Broad St., Lynn, Mass.

Electromagnetic Delay Lines 469

Modular type electromagnetic delay lines, Series DL-251, may be gauged for printed circuit applications. Impedances range from 300 to 600 ohms with delay times of 0.1 to 0.8 μsec. Delay to rise time ratios of up to 10 to 1 are available. Temperature range is —55 to +105 C. IMC Magnetics Corp., Dept. ED, 570 Main St., Westbury, L.I., N.Y.

Carbon Potentiometer 470

Designed to provide increased reliability up to 150 C, the model 3051 is completely sealed against humidity. The resistance range is 20 K to 1 meg; power rating is 0.25 w at 50 C. It is 1.25-in. long, 0.32-in high, and 0.19-in wide. Its operating temperature is —65 to 150 C. Bourns, Inc., Dept. ED, 6135 Magnolia Ave., Riverside, Calif.

Variable Trimmer Capacitor 471

Built with a sliding piston for fine tuning action, this trimmer capacitor is for use with cam-driven mechanisms. They are available, in all capacitances from 0.6 to 90 pf, in quartz or glass dielectric, in standard, differential, split-stator, open or sealed construction. JFD Electronics Corp., Dept. ED, 6101 Sixteenth Ave., Brooklyn 4, N.Y.

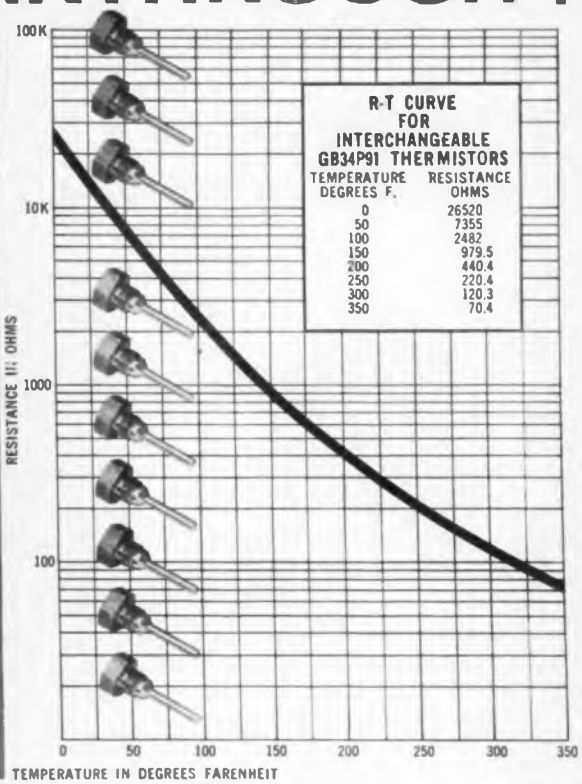
Telemetry Multicoupler 472

Eight receivers may be operated simultaneously from one antenna or preamplifier through the TMC-2 vhf telemetry multicoupler. There is 60-db minimum isolation between outputs. Each receiver may be tuned to any frequency between 225 and 256 mc. Defense Electronics, Inc., Dept. ED, 5451-B Randolph Road, Rockville, Md.

BREAKTHROUGH !

in thermistor design

Fenwal Electronics new "identical" thermistors permit complete



interchangeability !

What do you need from a thermistor in the way of performance? Reliability? Extreme stability? High shock resistance? Long life? Fenwal Electronics can supply it. But Fenwal Electronics' thermistors provide an additional important characteristic all their own: **they can be supplied with identical resistance temperature curves.**

That means that now, for the first time, you can have complete interchangeability. It means you can rely absolutely on consistently accurate resistance changes versus temperature of Fenwal Electronics' thermistors. It means also you can now achieve accurate, multi-point temperature indication or control through a single system without having to calibrate out each individual sensor.

From Fenwal Electronics... THE MOST COMPLETE LINE OF PRECISION THERMISTORS

BEADS & GLASS PROBES 0.006" to 0.100" diameter. Resistance values 500 ohms to 100 megohms

DISCS 0.1" to 1" diameter. Resistance values 5 ohms to 1,000 ohms

WASHERS .75" diameter. Resistance values 5 ohms to 3,000 ohms

RODS 0.053" to 0.173" diameter varying lengths. Resistance values 500 ohms to 500,000 ohms.

PROBE Assemblies Built to your specific requirements, enclosed and mounted in individual housings or "packages" and ready to install

E-I Matched pairs Thermistor beads matched to voltage current characteristics and mounted on special hermetically sealed stems designed for use in thermal conductivity gas analysis instruments.

From Fenwal Electronics... MORE HELP ON THERMISTOR PROBLEMS

• Thermistor Experimental Kit — to help you expedite operations at the bread board stage. Just $19.95 at electronics jobbers

• New Thermistor "Computer" — 5" x 8" "computer" reduces lengthy computations to single "slide rule" setting. Yours for the asking

• New Probe and Housing Brochure — Gives selection of probe designs

• New Thermistor Catalog EMC-3

For complete information, or the name of the Fenwal Representative in your area, write:

Fenwal Electronics

33 MELLEN STREET, FRAMINGHAM, MASSACHUSETTS

"Probes can be supplied individually calibrated at all desired temperatures. When interchangeability is required, they can be supplied with identical resistance-temperature characteristics.

CIRCLE 70 ON READER-SERVICE CARD

NEW PRODUCTS

Logic Kit 624

Consists of nine 500-kc building blocks

This logic kit consists of nine 500-kc building blocks: a logic inverter package, a dual diode NOR, four flip-flops, a delay, a clock and a pulse generator. A mounting panel, a power supply and 100-patch cords are also furnished. The kit is suitable for design work.

Digital Equipment Corp., Dept. ED. Maynard. Mass.

Price: *$1,038.*

Availability: *From stock.*

Temperature-Control System 386

This temperature-control system is designed for delicate electronic instruments and is simple and compact in design. Flow rate is 0 to 5 gal per min; various liquid coolants can be used. It maintains a selected temperature level to ±2 deg for any desired period.

Progressive Welder and Machine Co., Dept. ED. 915 Oakland, Pontiac, Mich.

Availability: *From stock*

Low-Speed Generators 571

Deliver 60 cps at 1,200 rpm

The new NoBrush generators for low-speed, 60 cps applications deliver 60 cps at 1,200 rpm with a power rating of 0.25 kva, three phase. Using brushless, permanent magnet design, the units reduce operating maintenance. They stand high ambient temperatures. Dimensions are 6-1/2 x 10-1/2 x 9 in. and weight is 50 lb.

Georator Corp., Dept. ED, Manassas, Va.

Jet-Spray Cleaner 573

For cleaning voltage regulators

This cleaning unit, designated model D1-0997, is designed to clean 360 voltage regulators per hour. A pneumatically indexed roller-type drag chain is used to move the regulator assembly from left to right in front of the operator. Because of a sensing device in the machine, the solvent will spray only when the unit is in position.

Cobehn, Inc., Dept. ED, Passaic Ave., Caldwell, N.J.

Zener Diodes 358

Handle 250 mw

Zener diode types 1N702 through 1N724 have dynamic resistances ranging from 10 to 60 ohms for low voltage and 3.6 to 60 ohms for medium-voltage units. Normally, with 10% tolerance, "A" type Zeners are available at 5% voltage tolerance. The diodes operate from −65 to +175 C. Specifications for the 1N702 are: breakdown voltage, 3.2 v max; inverse current, 75 μa max at 25 C; power rating, 250 mw max.

Hughes Aircraft Co., Semiconductor Div., Marketing Dept., Dept. ED, Newport Beach, Calif.

Pressure Switch 413

Accuracy is 1/2%

Model 400100 pressure switch for absolute, differential or gage pressure, is available in settings from 0.2 to 250 psi. Accuracy is 1/2%. A wide band of adjustment is provided for a given switch pressure. The unit performs under 40-g vibration. Contacts are isolated from the pressure-sensing cavities.

Wallace O. Leonard, Inc., Dept. ED, 373 S. Fair Oaks Ave., Pasadena, Calif.

NEW PRODUCTS

Subminiature Subcarrier Oscillator 414

Needs no output filters

This solid-state subminiature subcarrier oscillator has a sine-wave output, requiring no output filters. It employs reactive current feedback against overdrive. The unit has a maximum drift of 0.5% over the bandwidth over an 8-hr period. A 10% variation in power supply voltage will produce a frequency shift of less than 0.05%. The device has a volume of 2.5 cu in. and weighs less than 2.5 oz.

Electrosolids Corp., Solidtronics Div., Dept. ED, 14751 Keswick St., Van Nuys, Calif.

Price & Availability: *Devices are priced from $250 to $450. Delivery will be from stock by Sept. 15, 1960.*

Accelerometer 415

For missile applications

This 3-axis accelerometer with potentiometer output is intended for missile applications. The instrument measures 2 in. long by 2-1/2 in. in diameter and weighs about 1/2 lb. It is hermetically sealed, operates from −65 to +180 F with a relative humidity of 100% at any altitude. It is not damaged by acceleration or shock over 6 msec of 75 g.

Humphrey, Inc., Dept. ED, 2805 Canon St., San Diego 6, Calif.

Price & Availability: *Units are made to order from stock parts and can be delivered in 30 to 60 days; prices range from $725 to $850.*

General Electric Semiconductor News

G.E. improves 2N404 and 2N404A

Absolute Maximum Ratings (25°C)

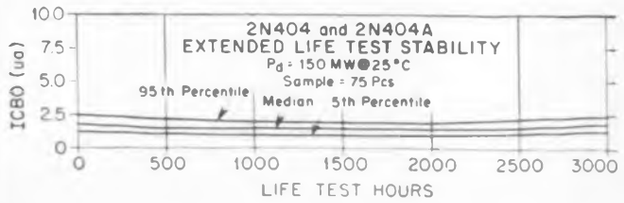
	2N404	2N404A
Voltages		
Collector to Emitter	−24 volts	−35 volts
Collector to Base	−25 volts	−40 volts
Emitter to Base	−12 volts	−25 volts
Collector Current	−100 ma	−150 ma
Power Dissipation at 25°C	150 mw	150 mw
Power Dissipation at 55°C	75 mw	90 mw
Power Dissipation at 70°C	35 mw	60 mw
Storage Temperature	−65°C to 100°C	−65°C to 100°C

2N404 and 2N404A Test Performance
(Incoming-to-Warehouse)
Life Tests, Mechanical/Environmental Tests

Test	Failures	% of Failures
Temperature Cycling	0/700	0.0
Thermal Shock	0/700	0.0
Moisture Resistance	0/700	0.0
Constant Accel. (5000 G)	5/675	0.74
Vibration Fatigue (10 G)	3/670	0.44
150 mw Life—1000 hrs.	2/725	0.27
25°C Storage—1000 hrs.	0/725	0.0
100°C Storage—1000 hrs.	1/195	0.5

The most thorough characterization ever published is your key to high reliability and stability for computer circuits designed around General Electric's *new* 2N404. G.E. specs tell the *complete* story of built-in performance for this field-proved high frequency switching transistor. For higher voltage circuits, the 2N404A offers 50% higher voltage ratings, new standards of reliability. Both units employ a specially designed "getter" to eliminate residual gases and vapors, assure electrical stability. The Kovar metal-to-glass hermetic seal minimizes leakage problems, offers maximum protection against thermal shock and cycling. Every unit is aged for an entire week at 100°C. The 2N404 and 2N404A are built to the same high standards as the USAF 2N404 (MIL-T-19500/20).

The extended life test charts shown indicate the exceptional performance of the 2N404 and 2N404A under rugged test conditions. Complete technical data available from your Semiconductor Sales Manager, or from the factory.

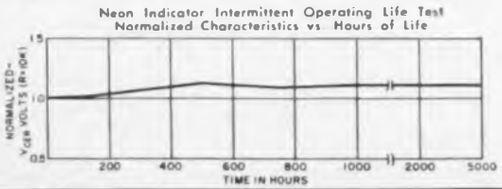


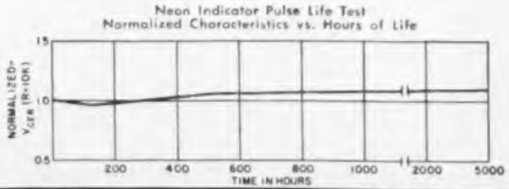
New High Voltage NPN Transistor permits neon indicator operation above 70°C

Specifications, Type 2N1510
Absolute Maximum Ratings (25°C)

Voltages	
Collector to Emitter	70 volts
Collector to Base	75 volts
Emitter to Base	8 volts
Collector Current	20 ma
Power Dissipation	75 mw
Storage Temperature	−55°C to 85°C
Operating Junction Temperature	85°C
Lead Temperature 1/16", 1/32" from Case for 10 seconds	230° C

General Electric's 2N1510 is a highly reliable germanium rate grown transistor especially characterized for operation at high voltages and low currents. The maximum collector leakage current is 5 microamperes at 75 volts and 25°C. This exceptionally low leakage current permits operation at high voltages and high ambient temperatures without the danger of thermal runaway, a serious problem with other types of germanium high voltage transistors. The 2N1510 is well suited for such applications as neon indicator drivers, direct indicating counters, drivers for high inductance loads, and high impedance-high voltage matching circuits. Every unit is aged at 100°C for 100 hours to assure stability of electrical characteristics, and that's only one of the many quality control and quality assurance methods employed by G.E. See the 5000 hour life test charts below for the evidence of long term reliability under high voltage operation.





Indicating Temperature Control 587

Range is −150 to +650 F

Type E32NA temperature control, having a range of −150 to +650 F, is suitable for use in ovens, baths, environmental changers and molding machines. The control contains two separate switches to permit switch action above or below the index set point and control of up to four independent circuits. Electrical rating is 15 amp at 115 or 230 v ac.

United Electrical-Controls Co., Dept. ED, 79 School St., Watertown 72, Mass.

Tachometer Generators 485

These tachometer generators are designed to provide speed indication for machine tools involving speeds up to 5,000 rpm. Available in ac or dc models, the tachometers have base mounts adaptable to a variety of mounting arrangements. Minimum full-scale speeds range as low as 0 to 300 rpm with suitable accuracy. Units have rated outputs of 20 v per 1,000 rpm.

General Electric Co., Dept. ED, Schenectady 5, N.Y.

Pyrometer Controller 574

Accuracy is 0.5% against scale

This heavy-duty pyrometer controller has a minimum full-scale span of 10 mv, ±0.5% accuracy against scale and ±1% accuracy within an ambient temperature range of 50 to 120 F. The unit has a galvanometer sensing element, a high-resistance input circuit and spring-backed jewel bearings for shock resistance. All control relays are internal and have a 10-amp rating at 120 v.

Daystrom, Inc., Weston Instruments Div., Dept. ED, 614 Frelinghuysen Ave., Newark 12, N.J.

NEW PRODUCTS

Noise Generator 596

Has separate generating head

Intended for operation in the vhf range, this noise generator provides direct readings with laboratory-grade accuracy. The noise-generating head connects to the main housing by a flexible cable. This arrangement allows the head to be attached directly to the receiver under test and eliminates long connecting leads. The instrument provides direct reading to 25 db into a 50-ohm impedance.

Gonset Division, Young Spring & Wire Corp., Dept. ED, 801 S. Main St., Burbank, Calif.

Thermo Wire Stripper 416

This device strips wire insulation while soldering without a change in tools. It slips over the barrel of the firm's soldering tips or heating units. Type designations are 7951, 7952 and 7953.

Ungar Electric Tools, Dept. ED, 4101 Redwood Ave., Los Angeles 66, Calif.
Price: *$0.75 per unit.*
Availability: *Through distributors.*

Heat Exchanger 580

Removes heat at the rate of 3 kw

This heat exchanger removes heat at the rate of 3 kw for cooling transmitter components of a missile tracking system. In this application, the air mover circulates 600 cfm of sulfur hexafluoride over cooling coils through which water is circulated.

IMC Magnetics Corp., Dept. ED, Westbury, L. I., N. Y.
Availability: *Made on order to customer specs.*

CIRCLE 75 ON READER-SERVICE CARD

this is the Brush Mark II... anyone can plug it in put it in writing anywhere

There is no direct writing recorder on the market that approaches the compact Mark II in sheer usefulness. It is a completely integrated engineering tool that can be operated by anyone . . . in the shop or in the field . . . for countless research or design requirements. Every function necessary for uniform, crisp, easily reproduced readouts is "built-in". The Mark II gives you two analog channels plus two event markers; 4 chart speeds; DC to 100 cps response with 40 mm amplitude; 10 mv/mm sensitivity; high input impedance. Ink or electric writing models. Immediate shipment from stock.

brush INSTRUMENTS
DIVISION OF
37TH AND PERKINS CLEVITE CORPORATION CLEVELAND 14, OHIO

Cubic precision digital voltmeter withstands 50G shock

A new militarized version of the Cubic precision digital voltmeter is guaranteed to withstand shocks as high as a bone-crushing 50 G. The ability to shake off punishment that would wreck ordinary voltmeters, and to keep on performing perfectly for years and years under the hardest kind of use, is built into *every* Cubic digital voltmeter. These meters are "operator-proof" – they will not be damaged by any except the most flagrant misuse. Even voltages 100% over the top of the highest range will not harm them.

The advanced engineering of Cubic's transistor-driven stepping-switch design provides extraordinary reliability and accuracy. Cubic digital voltmeters achieve 99.997% repeatability, for precise accuracy again and again. Attenuator accuracy is 0.003% for wide-range precision. Bridge linearity of 0.003% is attained with carefully matched quality components. Noise rejection (60 cps) is 80 db.

Cubic's digital readout is simple, reliable and the easiest to read at a glance. Extra quality components throughout ensure minimum maintenance requirements. Before buying *any* digital instrument, investigate the best. *Write for descriptive literature to Dept. ED-100, Industrial Division, Cubic Corporation, San Diego 11, Calif.*

BRIEF SPECIFICATIONS — MODEL 2100

ENVIRONMENTAL

shock test: will withstand 50G Navy shock test, and shipboard vibration

humidity: 100%

salt spray and fungus resistant

ELECTRICAL

volts: 0.01% accuracy from 1 millivolt to 1000 volts, automatic ranging and polarity

ohms: 0.1 ohm to 10 megohms, manual ranging

input power: 25 watts

ratiometer provision and switching

MECHANICAL

size: 5½" wide, 11¼" high, 14" deep

weight: 35 lb

cubic CORPORATION

CIRCLE 76 ON READER-SERVICE CARD

Liquid-Level Indicator 528

Uses no capacitors

This liquid-level indicator does not depend on capacitance or capacitors. It measures lubricants and other liquids in aircraft and industrial engines and in processing equipment. The elimination of capacitors enables the indicator to operate under severe conditions. The main components are an electronic control and a sensing element which are combined as a single unit.

United Aircraft Corp., Hamilton Standard, Dept. ED, Windsor Locks, Conn.
Availability: 90 to 120 days.

Transistor Troubleshooting Kit 387

Model HK46 troubleshooting and replacement kit consists of 12 transistors and one diode. They provide replacements for almost all types found in transistor radios. The kit is housed in a six-drawer, polystyrene cabinet.

Motorola, Inc., Dept. ED, 4545 W. Augusta Blvd., Chicago 51, Ill.
Price: $18.95 list.
Availability: From stock.

Counter-Timer 620

Is solid state

Model 728A, solid-state counter timer is available with standard vertical decade number panels or in-line Nixie readout. The device combines the functions of a counter, time-interval meter and frequency-period meter. Seven basic functions are selected by a front panel switch. Measurement ranges are: dc to 20 mc for frequency, 0.1 μsec to 10^7 sec for time interval, 0.1 μsec for period. Accuracy is ±1 count not including oscillator stability, sensitivity is 0.25 v rms and input impedance is 25 K per v.

Computer-Measurements Co., Dept. ED, 12970 Bradley Ave., Sylmar, Calif.
Price: $2,950.

Speaking of filters, Rantec is way up front. Men who know filters best in such projects as Mercury, Titan, Polaris and Discoverer—choose Rantec two to one. Why? Strictly the result of Rantec's superb miracle blend of research and development. Broadband Harmonic Filters from C through K_a bands rejecting the second and third harmonics of any frequency in the pass-band region . . . Waveguide Band-Pass Filters employing from one to fifteen cavities with precise equal-ripple, maximally flat insertion loss or maximally flat time-delay response . . . **Coupled Coaxial Resonator and Coaxial Low-Pass, High-Pass and Band-Pass Filters** in frequency ranges from 100mc to 10,000mc . . . **Stripline Diplexing Filters** to meet specific customer specifications for packaging, frequency band, response, isolation and power rating. Below . . . the **FS-203 Band-Pass Filter**—pass-band 2,000-4,000mc; stop-bands 0-1,800mc, 4,400-12,000mc; VSWR in pass-band 1.5 max.; insertion loss 1db max. in pass-band, 50db min. in stop-bands; impedance 50 ohms. **Reach for a Rantec** . . . available in crush proof and soft pack! Also from Rantec . . . antennas, ferrite devices, waveguide components, electric components and microwave sub-systems.

rantec

Rantec Corporation • Calabasas, California

CIRCLE 78 ON READER-SERVICE CARD

NEW PRODUCTS

Hard-Glass Resistor 532

Has high power rating

Type CG 1/4 hard-glass, carbon-film resistor guarantees 1/4-w dissipation from a package meeting MIL-R-10509C for 1/8-w resistors. The units cannot suffer case damage from lead tension because the loads are transmitted directly to the ceramic core. The glass case is sealed to the end caps of the core and does not touch the leads. The units are designed to resist thermal shock.

Texas Instruments, Inc., Dept. ED, P. O. Box 312, Dallas 21, Tex.

Availability: *Immediate, through distributors.*

Motor Generators 385

This line of low-null, size 8, motor generators provides a scale factor of 1 v per 1,000 rpm. Null is 0.01 v, permitting a sensitive and accurate servo system.

Daystrom, Inc., Dept. ED, Murray Hill, N.J.

High-Megohm Bridge 630

Measures 10^5 to 10^{15} ohms

Model 515 megohm bridge measures 10^5 to 10^{15} ohms with an accuracy of 0.05% to 1%. It can be used for standardization and calibration and for measurement of resistor-voltage coefficient, leakage and insulation resistances. Features include a shielded measuring compartment, a sensitive null detector with non-linear off-null indication, self-contained bridge potential and bench or rack operation. A remote test chamber is available for testing insulation or making other external measurements.

Keithley Instruments, Inc., Dept. ED, 12415 Euclid Ave., Cleveland 6, Ohio.

Price: *$1,500.*

Continuous Duty AC Motor 610

Is rated at 0.6 hp

This continuous-duty, 400-cps, three-phase ac motor is rated at 0.6 hp. Designated model 3760, the motor has a self-contained clutch brake and is designed to meet MIL specs for aircraft-hoist applications. At 0.6 hp, speed is 7,350 rpm. Operating at 0.9 hp on intermittent duty, the unit has a speed of 6,700 rpm. The unit weighs 8.4 lb., has a height of 4.1 in. and is 6.25-in. long.

Hoover Electric Co., Dept. ED, Hangar Two, Port Columbus Airport, Columbus 19, Ohio.

Ceramic Insulation Tubes 406

The tubes, offered in steatite or high alumina, have ID's measuring from 0.015 to 0.3 in. and OD's ranging from 0.156 to 0.395 in. Lengths are 0.25 to 2.25 in. They meet Mil specs for thermal cycling.

Centralab, Div. of Globe-Union, Inc., Dept. ED, 900 E. Keefe Ave., Milwaukee 1, Wis.

Price & Availability: *$70 to $120 per thousand for steatite tubes and $120 to $210 for high alumina tubes. Delivery is 3 to 4 weeks.*

Test Jack 530

For mounting printed-circuit boards

This test jack is for closer back-to-back mounting of printed-circuit boards. It has a nylon insulator and a beryllium-copper, spring-pin contact. Contact sleeves are silver- and gold-plated for ease in soldering. Mil material specs are met. The units are connected by dip-soldering.

Raytheon Co., Industrial Components Div., Dept. ED, 55 Chapel St., Newton 58, Mass.

Price: *$0.18.*

Availability: *One week.*

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Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.

CIRCLE 81 ON READER-SERVICE CARD

NEW PRODUCTS

Tape Recorder and Playback Unit 568

Completely self-contained

Model DS-7 flatbed tape recorder and playback unit is for direct, magnetic-tape recording. Static- and dynamic-time correction can be introduced on playback. Power is supplied by a 12-v battery. The firm's M4E amplifier is designed to match the unit.

Electro-Technical Labs, Div. of Mandrel Industries, P. O. Box 13243, Houston 19, Tex.
Price: *$8,750.*
Availability: *Two weeks.*

Epoxy Resin 428

META-CAST 441 is a two-part 100% solids casting and sealing compound. It can be cured at room temperature. Applications include potting and encapsulation of components such as coils, resistors, transformers, rectifiers and capacitors.

Metachem Resins Corp., Mereco Products Div., 530 Wellington Ave., Cranston, R.I.

Focus Coil 429

For high-resolution applications

Type F40 focus coil is designed for applications such as 1,000-line TV radar and photography displays. Static and dynamic coils are contained in a single unit. Both static and dynamic coil portions of the unit are available in a wide range of impedances. Efficient heat dissipation permits using the unit to 25 kv, accelerating potential.

Syntronic Instruments, Inc., Dept. ED, 100 Industrial Road, Addison, Ill.

Stabilized Amplifier 545

For analog computer applications

Model C/100/SB stabilized amplifier is for analog computer applications. Specifications include: gain, 2,000 dc min; stability, below 0.1 mv; output range, ±40 v; output impedance, 1 meg; power requirements, 2.5 ma at 300 v dc and 0.45 amp at 6.3 v ac, 60 cps. The unit measures 2-5/16 x 1-1/2 x 4-5/8 in. max.

Embree Electronics Corp., Dept. ED, 993 Farmington Ave., West Hartford 7, Conn.
Price: *$55 ea, 1 to 5 units.*
Availability: *10 days.*

DC-DC Converter 581

Model 1129 has 0.1% regulation for a ±10% line change as well as 100% load change. The input is 28 v dc and the output is 150 v dc at 0 to 250 ma. Ripple is 0.5% peak-to-peak. The unit weighs 3.2 lb, measures 3.75 x 4.5 x 3.75 in. and meets MIL-E-5272C.

Power Instruments Corp., Dept. ED, 235 Oregon St., El Segundo, Calif.

Solid-State Thermocouple 431

Provides temperature of 100 C

Model TR-100 solid-state thermocouple reference provides a constant reference temperature of 100 C, ±0.1 C, with a 10-channel uniformity of ±0.1 C and a maximum drift of less than 0.25 C over a range of −55 to +85 C. Power consumption is 1 w nominal over a variation of 90 to 125 v and a frequency range of 50 through 1,000 cps. For airborne applications, the unit measures 3-1/8 x 3-1/4 x 2-1/8 in. and weighs 12 oz approx.

Genistron, Inc., Dept. ED, 6320 W. Arizona Circle, Los Angeles 45, Calif.

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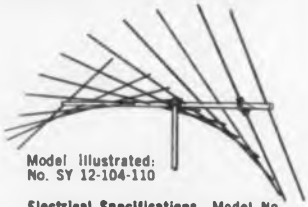
Model illustrates a wide-spaced, 12 element circular polarized optimum-tuned skewed dipole "SPIRALRAY" antenna. Provides unusually high gain, even response, in all polarization planes, vertical, horizontal or oblique with unusually high signal-to-noise ratio.

NO OTHER CIRCULAR POLARIZED ARRAY known to the art today can provide the linear high gain and signal-to-noise ratio in all radiation planes.

The ideal antenna for missile tracking, telemetering and no-fade response to mobile (or moving) stations.

Models available to extend the practical range of 2-Way Communication Systems.



Model illustrated:
No. SY 12-104-110

Electrical Specifications—Model No. SY-12-104-110: Polarization, circular, linear within ½ db. Gain 13 db. F/B-Ratio 30 db. V/S/W/R (50 ohm cable) 1.1/1. Beamwidth at half power points 33 degrees. Max. power input 300 w, with "Balun" supplied.

Mechanical Specifications: Boom diameter 2" O.D. x 25 ft. All aluminum boom and elements. Weight approx 25 lbs. Rated wind-load 90 mph. No ice load. Available for 120 mph wind load. (Model No. MSY-104-110).

Model SY-12-104-11
$265.00

Model MSY-104-110
$290.00

(f.o.b. Asbury Park, N. J.)

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CIRCLE 84 ON READER-SERVICE CARD

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No holding power needed with this new Transco switch. Solenoids stay cool, ending heat worries. Compact unit operates to 11 KMC and meets military specifications. Typical specifications at 7 KMC: IMPEDANCE 50 ohms; VSWR 1.3; INSERTION LOSS 0.3 db; CROSSTALK 40 db; WEIGHT 8.7 oz. Please write Transco Products, Incorporated, 12210 Nebraska Avenue, Los Angeles 25, California for complete information.

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COAXIAL SWITCHES • WAVEGUIDE SWITCHES • ANTENNAS • MICROWAVE COMPONENTS • VALVES • ACTUATORS

CIRCLE 85 ON READER-SERVICE CARD

NEW PRODUCTS

Overload Circuit Breaker 434

Protects transistors

The model CB-20 overload circuit breaker protects transistors against damage from current overload, short circuit, thermal runaway, and over-voltage punch-through. The device has load-current sensitivity of 200 ma at 20 amp load and turn-off time of less than 1 μsec per ampere beyond the selected break delay. Current limit can be varied from 2 to 20 amp. Reset is manual or automatic at 2 sec intervals. The device can also function as a power-pulse modulator, supplying up to 30-amp pulses with durations of 0.1 to 100 msec at a two-second repetition rate.

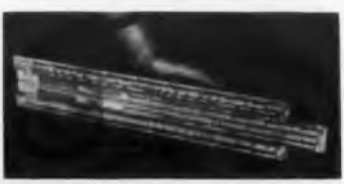
P. R. Mallory & Co., Electronics Div., Dept. ED, Indianapolis 6, Ind.

Price: *$390.*

Availability: *20 days.*

Radiation Slide Rule 533

Permits one-step calculations



This slide rule, made by A. G. Thronton Ltd. of England, provides information with one setting of the slide and/or cusor. Direct reading of values in watts and photons per square centimeter is possible in every case. Temperature scales provide readings in centigrade or degrees absolute over the range of −180 to 10,000 C. Quantities such as radiant flux density in a given wavelength or the corresponding quantities in photon units can be obtained readily for a black body over a range of $\lambda T = 2X10^2$ to $\lambda T = 4X10^6$ micron-degrees. Accuracy in this instance is about 1%.

Walsh Engineering Sales Co., Dept. ED, Inglewood, Calif.

Price: $41.

Temperature Recorder 597

Operates from thermocouple

This miniaturized temperature recorder operates directly from a thermocouple without signal amplification. Electrical connections required to operate the Temprint are the thermocouple and a 115-v ac line. Minimum temperature span is 0 to 500 F; maximum span is 0 to 2,500 F. Accuracy is ±2% of full scale. Standard chart speed is 1 in. per hr. The unit measures 3-5/8 x 5-3/8 x 4-1/8 in. and weighs 3-1/2 lb.

Assembly Products, Inc., Dept. ED, Chesterland, Ohio.

Price: *$165 to $175, depending on range.*
Availability: *From stock after Dec. 15.*

DC Timers 436

Up to 2 spdt instantaneous interlocks can be furnished on these class 9050, type C timers. The units have timing ranges up to 3 min. They can be ordered with interlocks factory-installed; separate interlock kits are available for field installation.

Square D Co., Dept. ED, 4041 N. Richards St., Milwaukee 12, Wis.

Data Translator 552

With wide variety of input-output combinations

Model 210 is the basic translator for all the firm's data translators. Direct-coupled logic cards are incorporated into the system to suit it to particular applications. The input-to-output variations include: magnetic tape-to-magnetic tape, magnetic tape-to-punched tape, punched cards-to-magnetic tape, magnetic tape-to-plotter and punched tape-to-magnetic tape.

Beckman Systems Div., Dept. ED, 325 N. Muller Ave., Anaheim, Calif.

NEW PRODUCTS

Word Counter 437

Speeds are 60, 75 and 100 wpm

This word counter, operating at speeds of 60, 75 and 100 wpm, automatically measures message traffic on teletypewriter circuits. A built-in, transistorized line relay permits direct connection into any printing telegraph circuit. The word counter, powered by an induction motor at 105 to 125 v, 60 cps, works off any current from 20 to 60 ma without readjustments.

Comptometer Corp., Western Apparatus Co. Div., Dept. ED, 5600 Jarvis Ave., Chicago 48, Ill.

Rotary Multipole Switch 438

Type JM gives positive positioning at 30-deg intervals. It provides single-knob control of up to 75 poles, is available with 1 to 25 sections, and can be furnished in a variety of contact arrangements. Uses include complex-circuit control.

Electro Switch Corp., Dept. ED, King Ave., Weymouth, Boston 88, Mass.

Oven-Furnace 593

Heats to 1,600 F in 30 min

This high-temperature oven-furnace heats from ambient to 1,600 F in 30 min or less. The insulation used permits reflection of more than 90% of exposed radiant heat. It is claimed to operate on about half the wattage required for similar furnaces. It is available with an indicating-controlling pyrometer.

Shampaine Scientific Co., Dept. ED, 615 E. First Ave., Roselle, N.J.

Welding Head 592

Power rating is 500 w-sec

Model 1038 welding head has a power rating of 500 w-sec, foot-pedal actuation, controllable electrode pressure and automatic firing. It performs single, series or parallel welds for electronic assemblies, joins fine wire, ribbon and foils. Dimensions are 9-1/2 x 6-1/2 x 10 in.

Unitek Corp., Dept. ED. 950 Royal Oaks Drive., Monrovia, Calif.

Curing Agent 699

Araldite DP-116 for epoxy resins cures at room temperature in 45 sec to 5 min, depending on thickness. It is suitable for structural and electrical repair kits, laminating and gel coats and adhesives for reflectors.

CIBA Products Corp., Dept. ED, Fair Lawn, N. J.
Availability: Experimental samples can be furnished.

Automatic Timer 599

Cycles between −100 and +500 F

Model MR-1 automatic timer cycles temperatures between −100 and +500 F. Accuracy is ±0.5 F. When used with the timer, model 1060RF chamber can complete a cycle in 12 min total time. Individual high and low temperature timer adjustments permit independent time durations of up to 3 hr each for any pair of preselected high and low temperatures. A master timer permits cycling indefinitely or stops cycling after any period up to 24 hr. The timer measures 19 x 3-1/2 x 3-1/2 in.

Delta Design, Inc., Dept. ED, 7460 Girard Ave., La Jolla, Calif.
Price: *$245 ea.*
Availability: *21 days; from stock by Jan. 1961.*

NEW PRODUCTS

Remote-Controlled Attenuator 439

For dc to high frequencies

Model A-601 provides attenuation of any signal from dc to high frequencies. Encapsulated as a plug-in module with a 7-pin base, the unit measures 3/4 in. in diameter and 1-5/8 in. long. It can be used as an attenuator, automatic gain control, phase shifter and in other applications.

Straza Industries, Straza Electronics Div., Dept. ED, 790 Greenfield Drive, El Cajon, Calif.
Price: $22.50.
Availability: *Immediate.*

Cable Assemblies 441

Cable assemblies with TNC or TM rf connectors are available in an assortment of configurations. They can be specified to match standard rf cable to customers requirements.

General RF Fittings, Inc., Dept. ED, 702 Beacon St., Boston 15, Mass.

Digital Voltmeters-Ratiometers 608

Four- and five-digit types

Types V34A and V35A, four- and five-digit instruments, measure dc voltages from ±100 μv to ±1,000 v and dc voltage ratios from ±0.01% to ±99.999%. Accuracy is ±0.01% on dc voltages and ±0.01% to ±0.005% on voltage ratios. With accessories, both units measure ac voltages and low-level dc voltages. Completely automatic, they also have output for automatic data logging.

Non-Linear Systems, Inc., Dept. ED, Del Mar, Calif.
Price: Type V34A, $3,150; type V35A, $3,750.
Availability: *Less than 30-day delivery after December.*

Graphic Recorder 591

Measures down to 0.01 mv

Providing a span of 1 mv full scale and recording voltages down to 0.01 mv, model JY-120 recorder has a maximum signal-source resistance of 50 K. The pen speed is 0.5 sec full scale and accuracy is 0.5% of span limit of error. The input is floating and a separate chassis ground is provided. Chart width is 5 in.

Nesco Instruments, Inc., Dept. ED, 638 W. 17th St., Costa Mesa, Calif.

Price: $535.

Availability: *30-day delivery.*

Lamp Bank 442

Type LB-126, designed for standard relay-rack mounting, provides a visual decimal display in a projection type, one-plane presentation. The unit measures 3.5 x 19 x 6 in. Models with 2 to 8 digits can be furnished.

Datex Corp., Dept. ED, 1307 S. Myrtle Ave., Monrovia, Calif.

Digital Timer 611

Provides up to three outputs

Model 8000 digital timer provides up to three electrical decimal outputs representing the total count. The unit is designed for moderate-speed applications. The digital outputs are suitable for operating serial or parallel devices such as tape punches, printers, displays, and magnetic tape recorders as well as providing inputs to computers and data loggers. An external contact closure is used to operate the timers. Three and four-digit units can be furnished.

Chrono-log Corp., Dept. ED, P. O. Box 4587, Philadelphia 31, Pa.

Price & Availability: *$200 and up. Four to eight weeks are required for delivery.*

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NEW PRODUCTS

Thermocouples 443

Are up to 10,000 ft long

Model 600 thermocouples for temperature indication and control can be up to 10,000-ft long. The unit is a transistorized, panel mounting, dc electronic voltmeter that operates on signals too small to actuate an ordinary pyrometer. Input resistance is at least 100,000 ohms. Standard temperature ranges are: 0 to 300, 0 to 500, 0 to 750, 0 to 1,000, 0 to 1,500, 0 to 2,000, 0 to 2,500 and 0 to 3,000 F. Standard voltage ranges are 0 to 10, 0 to 30, 0 to 100 and 0 to 300 mv plus 0 to 1 v. Accuracy is ±2% of full scale.

Metronix, Inc., Dept. ED, Chesterland, Ohio.
Price: *$300.*

Magnet Materials 710

For use in core-type meters, Alnico VII-S has a non-oriented energy product of 2,500,000. It has a high coercive force, resisting demagnetization even when subjected to high environmental heat.

Indiana Steel Products Div., Indiana General Corp., Dept. ED, Valparaiso, Ind.

Hydrogen Thyratron 444

Switches 350-kw peak power

Type 7621/HY-2 hydrogen thyratron switches 350-kw peak power with 30-sec filament warm-up time. It can operate at 125 F without force cooling when operated at maximum plate dissipation factor of 2.7 x 10^9. The tube stands shock of 200 g at 11 msec and vibration from 0 to 2,000 cps at 20 g.

Edgerton, Germeshausen & Grier, Inc., Dept. ED, 160 Brookline Ave., Boston 15, Mass.
Price: *$350.*
Availability: *30-day delivery.*

Ceramic-Jacketed Resistors 445

Have flexible, insulated leads

These wirewound resistors are furnished with flexible, insulated leads issuing from one end of the resistor and providing complete insulation with no exposed terminals. The units can be mounted horizontally on or under a chassis or perpendicular to the chassis. Leads from taps on the resistor can also be brought out at the same end of the resistor.

Ohmite Manufacturing Co., Dept. ED, 3625 Howard St., Skokie, Ill.

Availability: Four weeks.

Miniatures Modules 446

Output is 250 mw to 2 w ac

The IM series are transistorized dc to ac units with multiple, low-level output ranges from 250 mw to 2 w ac. Input range is from 3 to 28 v dc; standard temperature range is −55 to +85 C. Applications include multiple, low-power voltages for transistor circuitry and power for choppers and magnetic amplifiers. The units are also suited for missile and satellite requirements.

Transformer-Electronics Co., Dept. ED, Industrial Park, Boulder, Colo.

Angle Indicator 546

Two-speed type

The CO2721027 angle indicator provides numerical indication of the angular position of any mechanical device to which remote two-speed transmitters can be coupled. It can be supplied with dual-sensor speed ratios from 18:1 to 75:1. Single-speed accuracy is ±6 min; two-speed accuracy is ±15 sec. The unit measures 9-1/4 x 5-1/4 x 13 in., weighs 9-1/2 lb and requires 115 v of single-phase power at 400 cps.

Kearfott, Div. of General Precision, Dept. ED, 1150 McBride Ave., Little Falls, N.J.

CIRCLE 95 ON READER-SERVICE CARD ➤

NEW PRODUCTS

High Impedance Amplifier 422

Input impedance is better than 10^9 ohms

Model 360HI high-impedance amplifier has an input impedance of better than 10^9 ohms. Specifications include: input capacity, less than 10 pf; gain, unity; output impedance, 30 ohms; frequency response, 1 to 20,000 cps; temperature, 0 to 100 C. The unit measures 4 x 2-7/8 x 5/8 in. This transistorized amplifier is designed to provide a means of connecting high impedance piezo electric crystal accelerometers to recorders and similar equipment.

Halex, Inc., Dept. ED, 310 E. Imperial Highway, El Segundo, Calif.

Price: *$425 per unit, $315 in quantities of 10.*
Availability: *30-day delivery.*

Miniature Connectors 423

The 300 series of stainless steel connectors meet MIL-C-26500. Weight is about the same as that of aluminum connectors. Crimp-type contacts, conforming to MIL-C-26636, are restrained by protected metal collets.

The Pyle-National Co., Dept. ED, 1334 N. Kostner Ave., Chicago 51, Ill.

Wave Analyzer 425

For random vibration signals

Model OR-WA/1 wave analyzer is designed for spectral analysis of random or periodic vibration signals. Frequency response is from 25,000 cps to as low as 0.2 cps. The unit sweeps any 5% segment of any frequency band for any time up to 120 sec. Specifications include: voltage range, 0.01 to 10 v rms; dynamic range, 60 db; outputs, 10 v dc full scale from 50 K and 15 v ac full scale from 50 K; over-all amplitude accuracy, ±1% of reading; power requirement, 115 v ac, 500 w. Bandwiths available are 0.2, 5, 20, 50 and 200 cps.

Gulton Industries, Inc., Dept. ED, 212 Durham Ave., Metuchen, N. J.

Price: *$9,500 up.*
Availability: *Made on order, 90 day delivery.*

Frequency Discriminator 590

Range is 360 to 440 cps

Model 91-105-0 frequency discriminator has a frequency range of 360 to 440 cps with a sensitivity of 62.5 mv per cycle deviation. Its input signal range is 95 to 150 v ac with 2.5 va, max, power required. The output is 0 v at 360 cps to 5 v dc at 440 cps. Linearity is ±0.1% for full-scale output voltage; stability is ±0.1% of full scale for line voltage changes of ±10% and ±0.5% of full scale for ambient temperature ranges from −20 to +71 C. Frequency error is ±1.5 cps max.

Magnetic Research Corp., Dept. ED, 3160 W. El Segundo Blvd., Hawthorne, Calif.

Dynamic Load Analyzers 426

For power supply tests

Model RP-101 dynamic load analyzer is a vacuum-tube model that can load high-voltage power supplies from 50 to 500 v dc at 0 to 500 ma. Model RP-102 is a transistorized unit that can load high-current power supplies from 1 to 50 v dc at 0 to 50 amp. The units are for laboratory or production line inspection.

Anders Electronics, Inc., Dept. ED, Brook Road, Needham Heights 94, Mass.

Telemetry Discriminator 486

Occupies less than 1.5 cu ft

The Mini-Tel subcarrier discriminator, able to accommodate 14 IRIG channels, occupies less than 1.5 cu ft. Power requirement is less than 3 w per channel; it may be supplied from batteries or from v ac. Drift is under 1% in 8 hr over a temperature span of 80 F. The dc linearity is better than 0.5%. With flat frequency-response, low-pass filters, the output level is flat within ±0.5 db.

Precision Instrument Co., Dept. ED, 1011 Commercial St., San Carlos, Calif.
Price: *$700 per channel.*

Position Transducer 427

Uses non-contact sensing

Shaft rotation is sensed by non-contact magnetic heads on this position transducer. Output is a digital-pulse measurement of linear motion. The unit detects 0.0001 in. increments at speeds under 120 in. per minute, or increments of 0.001 in. at speeds above 200 in. per minute.

Rheem Manufacturing Co., Rheem Electronics Div., Dept. ED, 5200 W. 104th St., Los Angeles, Calif.
Price: $295.

NEW PRODUCTS

Differential Isolator 361

Isolation is 1 x 10^{10} ohms min

Model AA-131 differential isolator eliminates noise from data acquisition systems. Isolation is 1 x 10^{10} ohms min and 1 x 10^{-13} farads max. Common mode rejection is 130 db to 1 kc. Output is ± 5 v at ± 30 ma or ± 10v at ± 20 ma. Frequency response is less than 3 db down at 20 kc. Input impedance is 300 ohms; output is less than 15 ohms to 1 kc. The unit breaks ground loops in data-acquisition systems, converts a floating 3-terminal wideband dc instrument amplifier into a true 4-terminal wideband dc amplifier, and functions as a dc to 2-kc isolation transformer when used alone.

Computer Engineering Associates, Inc., Dept. ED, 350 N. Halstead St., Pasadena, Calif.

Scope Dolly 353

This scope dolly has an adjustable top angle that permits easy reading and lab movement of such instruments as oscilloscopes, oscillographs and other read-out or recording test gear. The work top, measuring 18 x 26 in., can be inclined and locked in seven positions.

Artisan Metal Works Co., Dept. ED, 11400 Madison Ave., Cleveland 2, Ohio

Natural Mica 368

This natural mica is for use as an anti-slip medium in electron power tubes to aid in maintaining critical assembly alignment. Pieces are production-punched to 0.005-in. tolerances from clear Indian ruby mica.

Ford Radio & Mica Corp., Dept. ED, 536-540 63rd St., Brooklyn 20, N.Y.

Availability: 2 to 4 days.

Silicon Rectifiers 351

Types 2N1595, 2N1596 and 2N1597 silicon-controlled rectifiers have voltage ratings of up to 200 v. Firing current is 10 ma. The cold-welded package is used and all leads are isolated. The units are pnpn type and meet MIL-S-19500 specs.

Solid State Products, Inc., Dept. ED, 1 Pingree St., Salem, Mass.

Off-the-shelf delivery at factory prices from these Corning distributors

ARIZONA, Phoenix
Radio Specialties & Appliance Corp
917 North 7th Street

ARIZONA, Tucson
Standard Radio Parts Inc
827 South Park Avenue

CALIFORNIA, Glendale 1
R. V. Weatherford Company
6921 San Fernando Road

CALIFORNIA, Inglewood
Newark Electronics Co., Inc
4747 West Century Blvd

CALIFORNIA, Los Angeles 15
Universal Radio Supply Company
1729 South Los Angeles Street

CALIFORNIA, Oakland 7
Elmar Electronics, Inc
140 11th Street

CALIFORNIA, Palo Alto
Zack Electronics
654 High Street

CALIFORNIA, San Diego 1
Western Radio & TV Supply Co
1415 India Street

CALIFORNIA, San Francisco 3
Pacific Wholesale Company
1850 Mission Street

CALIFORNIA, San Francisco 2
Zack Electronics
1C?? Market Street

COLORADO, Denver
Inter State Radio & Supply Company
1200 Stout Street

WASHINGTON 8, D.C.
Capitol Radio Wholesalers, Inc.
2120 22 14th St. N.W.

WASHINGTON 1, D.C.
Electronic Wholesalers Inc.
2345 Sherman Avenue, N.W.

FLORIDA, Melbourne
Electronic Wholesalers, Inc.
P. O. Drawer 1655
1301 Hibiscus Blvd

FLORIDA, Miami 32
Electronic Wholesalers Inc
61 N. E. Ninth Street

ILLINOIS, Chicago 6
Newark Electronics Corporation
223 West Madison Street

INDIANA, Ft. Wayne 1
Ft. Wayne Electronic Supply, Inc.
1606 Maumee Avenue

INDIANA, Indianapolis 25
Graham Electronics Supply Inc
122 South Senate Avenue

IOWA, Cedar Rapids
Deeco Inc
618 First Street N. W.

LOUISIANA, New Orleans 19
Electronic Parts Corp
1622 Toulouse Street

MARYLAND, Baltimore 1
Kann Ellert Electronics, Inc
2050 Rockrose Avenue—11

MARYLAND, Baltimore 1
Wholesale Radio Parts Co., Inc
308 310 West Redwood Street

MASSACHUSETTS, Boston 16
Cramer Electronics Inc.
811 Boylston Street

MASSACHUSETTS, Boston 17
Radio Shack Corporation
730 Commonwealth Avenue

MICHIGAN, Detroit 38
Ferguson Electronic Supply
2308 Puritan Ave

MINNESOTA, St. Paul 3
Stark Radio Supply Co
154 West University Ave (at Rice)

NEW JERSEY, Camden 2
General Radio Supply Co. Inc
600 Penn Avenue

NEW JERSEY, Mountainside
Federated Purchaser, Inc
1021 U. S. Route 22

NEW MEXICO, Alamogordo
Radio Specialties Co., Inc
209 Penn Avenue

NEW MEXICO, Albuquerque
Radio Specialties Co., Inc
6323 Acoma Road, S. E.

NEW YORK, Binghamton
Federal Electronics, Inc
P. O. Box 208

NEW YORK, Buffalo 3
Radio Equipment Corporation
317 Elm Street

NEW YORK, Hempstead
Davis Electronics Corporation
294 Main Street

NEW YORK, New York 7
Interstate Electronics, Inc
217 Fulton Street

NEW YORK, New York 6
Milgray Electronics, Inc.
136 Liberty Street

NEW YORK, New York 13
Milo Electronics Corporation
530 Canal Street

NEW YORK, New York 11
Terminal-Hudson Electronics, Inc
236 West 17th Street

NEW YORK, Poughkeepsie
Higgins & Sheer Electronic Dist.
105 Dutchess Turnpike

NEW YORK, Rochester 5
Rochester Radio Supply Co., Inc
600 East Main Street

NEW YORK, Syracuse 4
Morris Distributing Co., Inc
1153 West Fayette Street

NEW YORK, Utica 4
Valley Electronic Labs, Inc.
1415 Oriskany Street, West

NORTH CAROLINA, Winston-Salem
Dalton-Hege, Inc.
938 Burke Street

OHIO, Akron 8
The Sun Radio Company
110 East Market Street

OHIO, Cincinnati 10
Hughes Peters, Inc
1128 Sycamore Street

OHIO, Columbus 11
Hughes-Peters, Inc
481 East 11th Ave

OHIO, Cleveland [illegible]
Radio & Electronic Parts Corp.
[illegible] Prospect Avenue

OHIO, Dayton 4
[illegible], Inc
[illegible] Street

OKLAHOMA, Tulsa 15
Oil Capitol Electronics Corp.
Admiral Station Box GG
[illegible] South Sheridan

OREGON, Portland 9
United Radio Supply, Inc
22 N. W. Ninth Avenue

PENNSYLVANIA, Philadelphia 7
Almo Radio Company
[illegible] Arch Street

PENNSYLVANIA, Philadelphia 7
Herbach & Rademan, Inc
1204 Arch Street

PENNSYLVANIA, Pittsburgh 22
Cameradio Company
[illegible] Penn Avenue

PENNSYLVANIA, Scranton 3
Fred P. Pursell
[illegible] North Washington Ave

TENNESSEE, Nashville 4
Electra Distributing Company
[illegible] West End Avenue

TEXAS, Dallas [illegible]
Adleta Company
[illegible] McKinney

TEXAS, Houston [illegible]
[illegible] Electronic Equipment Co
[illegible] West Clay Street

UTAH, Salt Lake City [illegible]
Kimball Distributing Company
[illegible] Pierpont Avenue

VIRGINIA, Norfolk [illegible]
Priest Electronics, Inc
[illegible] Tidewater Drive

WASHINGTON, Seattle 1
Seattle Radio Supply, Inc
2117 Second Avenue

CANADA, Trenton, Ontario
Erie Resistor of Canada Ltd.
7 Fraser Ave.

ERIE
DISTRIBUTOR DIVISION
ERIE, PENNSYLVANIA

CIRCLE 101 ON READER-SERVICE CARD

CORNING GLASS RESISTORS

...from specification to application in 1 hour

Call your Corning distributor for electronic components you need in a hurry. He'll ship them immediately . . . via messenger or taxicab if necessary. Resistors or other reliable Corning components can be in your hands within an hour . . . or even a half hour, depending on the distance.

This quick service from complete stocks, plus technical assistance when you need it, makes your local Corning distributor a valuable asset to your operation. Give him a call and watch the results.

If you don't know the name of your nearest Corning distributor, write to: Electronics Distributor Division
ERIE RESISTOR CORPORATION
Erie, Pennsylvania

All Corning resistors, like this unfinished S type, start with PYREX brand glass. Metallic oxide becomes an integral part of the glass surface by bonding at red heat. Result: rugged resistors accurate up to 200°C —impervious to moisture.

CORNING
ELECTRONIC COMPONENTS
Distributed exclusively by
ERIE DISTRIBUTOR DIVISION

CIRCLE 102 ON READER-SERVICE CARD

WHAT THIS UNUSUAL AC-DC "PLUG-IN" TRANSISTORIZED POWER SUPPLY DESIGN GIVES YOU...

One piece finned aluminum extrusion, achieving high heat dissipation. Most units need no external heat sink to 55° C ambient. All units have adjustable output. Platform mounted standardized subassemblies and components enable quick delivery of a wide range of voltages and currents.

Specifications:

Input: 105 to 125V AC, 45 to 420 cps, single phase
Regulation: 0.1% (line or load)
Stability: Better than 0.25% for 8 hours
Ripple: 0.02% rms
Response time: less than 100 microseconds
Low dynamic impedance

Designed primarily as a component power supply, units are widely used in computors, electronic instrumentation, production test equipment, and quality control check out systems. Best of all, the unique design makes these units available at the lowest possible cost to you.

(Unit pictured above: Model =1R 90-.1; 85-95 V; 0-100 ma; Price $145.00) Prices on other units range from $100 to $200.

All solid state — zener diode reference; transistor amplifiers and regulator
Output Voltages: from 2.0 to 300V DC
Output Power to 30 Watts
Reliable short circuit protection
All components readily accessible

CONSOLIDATED AVIONICS CORPORATION

A SUBSIDIARY OF CONSOLIDATED DIESEL ELECTRIC CORPORATION

800 Shames Drive • Westbury, L. I. • EDgewood 4-8400

CIRCLE 103 ON READER-SERVICE CARD

NEW PRODUCTS

Servo Amplifier 376

Capacity is 90 w

The 90-w model SPA-1 servo power amplifier is designed to operate with high-acceleration two-phase ac motor-tachometer combinations. It provides the excitation, control, and feedback networks required by high-performance, high-power instrument servos. A velocity transition control circuit allows transition from velocity to straight-servo operation at a preset point from 10% to 100% of synchronous motor speed.

Radionics, Inc., Dept. ED, 76 Cambridge St., Burlington, Mass.

Price: *$390 ea, 1 to 4; $370 ea, 5 to 10.*

Availability: *From stock.*

Quick-Connect Terminals 365

These quick-connect terminals are available on the manufacturers resistor sizes from 5 to 200 w. The terminals do not require solder and are designed to permit disconnecting of leads with equal speed to simplify field service.

P. R. Mallory & Co., Inc., Mallory Controls Co. Div., Dept. ED, Frankfort, Ind.

Precision Gears 364

These precision gears cover diametrical pitch ranges of 24, 32, 48, 72, 80, 96, 120 and 200. They meet A.G.M.A. standards and are available in Precision 1, 2, 3 and ultra-Precision 1.

Sterling Precision Corp., Instrument Div., Dept. ED, 17 Matinecock Ave., Port Washington, L.I., N.Y.

Availability: *From stock.*

Adjustable Container Latch 360

Type 51L adjustable container latch is designed for use on reusable shipping containers, transit cases and component assemblies. Range of adjustment is 0.3 in. in vernier increments of approximately 0.02 in. per turn.

Camloc Fastener Corp., Dept. ED, 61 Spring Valley Road, Paramus, N.J.

Price: *$0.51 ea.*

Availability: *From stock after Dec. 1.*

Coiled-Line Stub Tuner 418

Matches any impedance to 50 ohms

The Rotary Rover No. D1140 is a coiled-line roving stub tuner. It matches any impedance to 50 ohms over the 900 to 12,400 mc frequency range. The unit is operated by two concentric knobs: the top one adjusts stub length, the lower one changes stub location.

Radar Design Corp., Dept. ED, Pickard Drive, Syracuse 11, N.Y.
Price: *$195 ea.*
Availability: *4 weeks*

Epitaxial Mesa Transistors 649

Typical storage time is 5 nsec

Type 2N828 germanium-epitaxial mesa transistors have a typical storage time of 5 nsec, measured in a micro-alloy test circuit. At a saturation current of 50 ma, the collector saturation voltage is 0.18 v. At 10 ma, saturation voltage is 0.12 v. The units have good power-handling capabilities and frequency performance and reduced collector capacitance.

Motorola Semiconductor Products, Inc., Dept. ED, 5005 E. McDowell Road, Phoenix, Ariz.
Availability: *From stock.*

Snap-Action Switch 419

For sensitive-switch applications

These snap-action switches have quick-connect terminals measuring 0.032 x 0.205 in. The 0.093-in. terminal hole also permits soldering. A coil-spring mechanism provides long life, low operation torque and frictionless blade pivot. Positive over-travel stops and dust-free flange are molded in the case. The switch is UL and CSA approved for 5 amp at 250 v ac.

Cherry Electrical Products Corp., Dept. ED, 1666, Deerfield Road, Highland Park, Ill.
Price: *$0.73 in lots of 10,000.*
Availability: *From stock to four weeks.*

CIRCLE 105 ON READER-SERVICE CARD ▶

NEW PRODUCTS

Pulse Generators 432

Provide four different pulses

Four models of the B-7B pulse generator combined with a mixing network produce four pulses of various specifications. One of the generators acts as a trigger source for the other units. Delays, widths, output, pulse position, polarity, and rise and fall time are independent of each other. Units may be stacked in a 19-in. rack cabinet. Specs for the B-7B are: 50-v amplitude delivered into a 50-ohm load, delay with respect to synchronous output, 0 to 10,000 μsec, width 0.05 to 10,000 μsec; repetition rate, 20 cps to 2 mc.

Rutherford Electronics Co., Dept. ED, 8944 Lindblade St., Culver City, Calif.

***Price:** $720 for each unit; $75 for mixer assembly.*

Data Translator 380

Converts paper tape to magnetic tape

The Model ZA-26065 data translator converts paper tape to magnetic tape for the IBM 704 or 705 format, and can be provided to convert tape for other computers. It accepts 5, 6, 7, or 8 level chad or chadless paper tapes in any coding. Data is read at 300 characters per sec on chad type or at 20 characters per sec on chadless tape. Solid-state plug-in circuits are employed.

Electronic Engineering Co. of California, Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif.

***Price & Availability:** Price of the unit is $49,500, and delivery is 90 to 120 days.*

Telemetering Filters 424

Have center frequencies to 70 kc

These subminiature telemetering filters are offered in 22 types with center frequencies of 400 cps to 70 kc. Input and output impedance is 100 K with an insertion loss of less than 6 db. Attenuation characteristics are 3 db with a bandwidth of ±7.5%, 20 db at ±25% bandwidth and 40 db at 0.58 and 1.75 times the center frequency. Sizes are: 11/16 x 1-9/32 x 2 in. for units with ratings to 1.7 kc and 3/4 x 3/4 x 1-3/8 in. for units rated at 2.3 to 70 kc.

Tortel, Inc., Dept. ED, 5512 E. 110th St., Kansas City 37, Mo.
Availability: 7 to 14 days.

Voltage Monitor 421

For 115-v, 400-cps systems

Model T166 direct-reading voltage monitor is designed for 115-v, 400-cps power systems. The unit records and displays: total time, in hours, that line voltage is applied to the instrument; total time, in minutes, that applied line voltage is above a selected preset value; and total time, in minutes, that applied line voltage is below a selected preset value. Over voltage and under-voltage preset is adjustable from 105 to 125 v. Readout is 9999.9 min for over-voltage and undervoltage and 9999.9 hr for total operating time.

Avtron Manufacturing, Inc., Dept. ED, 10409 Meech Ave., Cleveland 5, Ohio.
Price: $1,500.
Availability: Made on order.

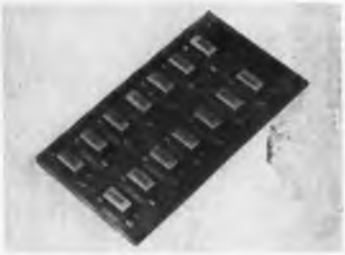
◀ CIRCLE 106 ON READER-SERVICE CARD

CIRCLE 107 ON READER-SERVICE CARD

NEW PRODUCTS

Voltage Divider 378

Has 15-bit accuracy



The model RVDM-305 relay-operated voltage divider has an absolute accuracy and resolution of 0.003%. Its response time is less than 15 msec. Mounted on a glass-epoxy card, the divider is 3-3/4 in. wide, 7-1/4 in. long, and 1-1/4 in. high. Environmental test specifications are met.

Julie Research Laboratories, Inc., Dept. ED, 603 W. 130th St., New York 27, N.Y.
Availability: *From stock by Jan. 1, 1961.*

Control-Knob Lock 366

This dust-proof knob lock is for exterior use with potentiometers and other variable controls. Water leakage is prevented by a rubber insert. The lock is mounted on the threaded bushing of the control. It meets MIL specs.

Raytheon Co., Industrial Components Div., Dept. ED, 55 Chapel St., Newton 58, Mass.
Price: *$1.65 to $1.85.*
Availability: *30 days.*

Conductive Ink 367

No. R-284-V conductive ink, for printed circuits, dries in 30 to 45 min. When deposited by screen process through 8xx mesh, conductivity rating is 3,000 to 5,000 ohms per in. It is available in pint, quart or gallon containers.

Advance Process Supply Co., Inc., Dept. ED, 2315 W. Huron St., Chicago 12, Ill.
Price: *Pint $5, quart $8.50, gallon $29.50.*
Availability: *Delivery from stock.*

Rare Earth Metals 369

These rare earth metals, available in 25-g-min lots, include dysprosium, erbium, gadolinium, holmium, samarium and ytterbium. Purity levels are: iron, less than 0.03%; tantalum, less than 0.01%; other rare earths, less than 0.1%; and silicon, calcium, etc., traces.

High Purity Metals, Inc., Dept. ED, 340 Hudson St., Hackensack, N.J.
Price: *$1.30 to $2.25 per g.*
Availability: *15 to 30 days.*

Micro-Alloy Transistors 435

With diffused-bases and cadmium junctions

These transistors are adaptable for use in simple saturated circuits, offering low current, voltage and power requirements. They have ratings of: collector-to-base, 15 v; collector-to-emitter, 12 v; emitter-to-base, 2 v. Type 2N501 dissipates a total of 25 mw at 45 C and type 2N501A dissipates 60 mw. The units are pnp, germanium types.

CBS Electronics, Dept. ED, Danvers, Mass.

Availability: Immediate.

Servoamplifier 450

For torquemotors and dc servomotors

Model 914 servoamplifier drives torquemotors and dc servomotors. Gain is 0 to 25 ma per volt for single and differential current drive, 0 to 100 v per volt for voltage drive. Effective source impedance is greater than 1 meg for differential current drive, greater than 100 K per ohm for single current drive, and less than 1 ohm for voltage drive. Frequency response is flat at 0 to 2,000 cps, resistive; 0 to 600 cps with an inductive load of 4 h. Linearity is better than ±1%. Receptables are provided for recorder or oscilloscope displays of output.

Industrial Measurements Corp., Dept. ED, 445 N. Garey Ave., Pomona, Calif.

***Price & Availability:** Approximately $500, 2 to 4 weeks after order received.*

CIRCLE 109 ON READER-SERVICE CARD ➤

The smooth, easy insertion and extraction action, the self-wiping, self cleaning features and the double-sided, flexing action of both mating contact members make Micro-Ribbons the first miniature connectors to provide reduction in size with added reliability.

☆ CINCH

MINIATURE BLUE RIBBON CONNECTORS

Bodies are molded of an improved Diallyl-Phthalate with extremely high impact strength and excellent dielectric features. (type MDG per MIL-M-14E) Contacts are plated .0002 silver plated plus .00003 gold. Shells are brass cadmium plated plus either clear chromate or yellow chromate per QQ-P-416 Type 2 Class 2.

CABLE-TO-CHASSIS MOUNTING TYPES

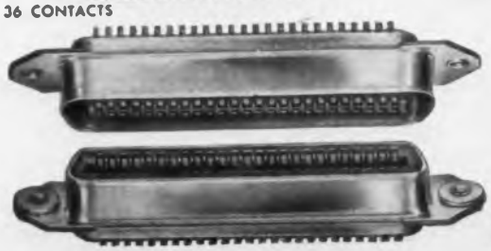
The compact housings are equipped with sturdy spring type latches on the receptacles which are guided and held by cut-outs in the plug flanges.

Receptacle shells have floating bushings allowing a float of .020 in each direction.

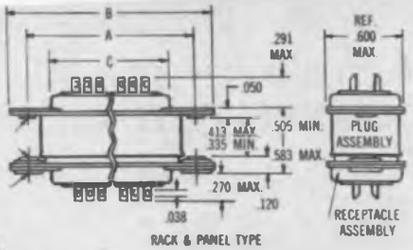
14 CONTACTS

24 CONTACTS

36 CONTACTS



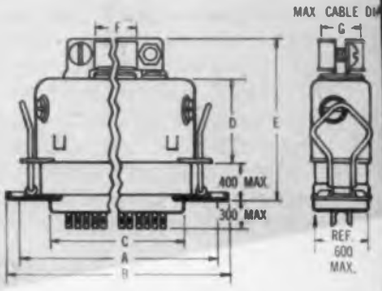
50 CONTACTS



RACK & PANEL TYPE

DIMENSIONS

		14 Contacts	24 Contacts	36 Contacts	50 Contacts
BOTH TYPES	A	1.417	1.842	2.352	2.947
	B	1.750 REF.	2.175 REF.	2.685 REF.	3.280 REF.
	C	.910 REF.	1.335 REF.	1.845 REF.	2.440 REF.
CABLE TO CHASSIS TYPE ONLY	D	.843	.843	.905	1.000
	E	1.668 MAX.	1.668 MAX.	1.730 MAX.	1.825 MAX.
	F	.306 MAX.	.473 MAX.	.640 MAX.	.766 MAX.
	G	.422 MAX.	.473 MAX.	.473 MAX.	.473 MAX.



CABLE TO CHASSIS TYPE

Centrally located plants at Chicago, Illinois; Shelbyville, Indiana; City of Industry, California; St. Louis, Missouri.

CINCH MANUFACTURING COMPANY

1026 South Homan Ave., Chicago 24, Illinois

Division of United-Carr Fastener Corporation, Boston, Mass.

RACK AND PANEL CODE NOS.

CONTACTS	PLUG	SOCKET
14	57-10140	57-20140
24	57-10240	57-20240
36	57-10360	57-20360
50	57-10500	57-20500

CABLE-TO-CHASSIS CODE NOS.

	PLUG WITH CAP	SOCKET WITH LOCK
14	57-30140	57-40140
24	57-30240	57-40240
36	57-30360	57-40360
50	57-30500	57-40500

NOTE: Above code nos. have shells cadmium plated plus clear chromate. For cadmium plus yellow chromate Add -1 to the nos. shown.

ELECTRONIC DOT ASSEMBLIES

RACK AND PANEL TYPES

☆ **Manufactured by agreement with Amphenol-Borg Electronics Corporation**

NEW PRODUCTS

Linear Ohmmeter 375

Functions as comparator

This ohmmeter features a linear scale. Voltage across the unknown resistor is limited to 1 v at low current. It can be used as a resistance comparator, with indication of 5% and 10% limits. There are 8 ranges, from 1-ohm full scale to 10-meg full scale. Ohmmeter range is shown by illuminated figures.

Research Industrial Laboratory of Electronics, Dept. ED, Roslyn, Pa.

Price: *$390.*

Availability: *4 to 8 weeks.*

Insulating Material 372

Epoxy-coated glass No. 2525 retains its characteristics under continuous 155 C operation. Compatible with all Class-F magnet wires and most epoxy systems, it is available in tapes, sheets, or 36-in. rolls in thicknesses of 0.003, 0.007 and 0.010 in.

Irvington Div., Minnesota Mining & Mfg. Co., Dept. ED, 900 Bush Ave., St. Paul 6, Minn.

Packaging Material 371

This reusable custom-designed packaging, of a closed-cell expanded plastic foam, provides shock protection in any mode of shipping. Abrasive-resistant and buoyant, the foam is unaffected by altitude, temperature variation, water, oil, or gasoline.

Pac-Tron Inc., Dept. ED, Willow St., Mystic, Conn.

Xenon Lamp 586

The rays of this xenon lamp can be projected for a distance of 50 miles. It is for military use, searchlights, projectors and space applications. It has a life of up to 1,000 hr.

Duro-Test Corp., Dept. ED, North Bergen, N.J.

Temperature Chamber 363

This diffused-air temperature chamber keeps temperatures to a maximum of 550 F across the entire area of each shelf.

Temperature Engineering Corp., Dept. ED, Riverton, N.J.

CIRCLE 111 ON READER-SERVICE CARD ➤

NEW UNIVERSAL SPECTRUM ANALYZER

Polarad Model SA-84W being used to make pulse analysis of radar aboard a Pan American Boeing 707, Jet Clipper®

MODEL SA-84W 10 to 44,000 MC in a single unit

FEATURES:

(A) Over 80 mc dispersion
1 mc to over 80 mc for narrow pulse analysis.

100 kc to 7 mc for wide pulse analysis.

(A) Dual Resolution
7 kc or 50 kc automatically set by dispersion control.

(B) Crystal controlled markers from 10 to 44,000 mc.

(C) Provision for use with a multi-pulse spectrum decoder (Polarad Model SD-1)

(D) Log-linear amplifiers

(E) Expanded, direct-reading, slide rule dial.

(F) Accurately calibrated IF attenuator

The Polarad Model SA-84W is the most accurate universal microwave analyzer to measure nearly all parameters — Pulse, CW, FM, VSWR, antenna patterns, bandwidths and filter characteristics.

FREE LIFETIME SERVICE ON ALL POLARAD INSTRUMENTS

MAIL THIS CARD for specifications. Ask your nearest Polarad representative (in the Yellow Pages) for a copy of "Notes on Microwave Measurements."

POLARAD ELECTRONICS CORPORATION

43-20 34th Street, Long Island City 1, N. Y.
Representatives in principal cities.

POLARAD ELECTRONICS CORPORATION: 12345678

Please send me information and specifications on:

- ☐ Model SA-84W Universal Spectrum Analyzer
- ☐ Model SD-1 Multi-Pulse Spectrum Selector (see reverse side of page)

POLARAD

My application is _____

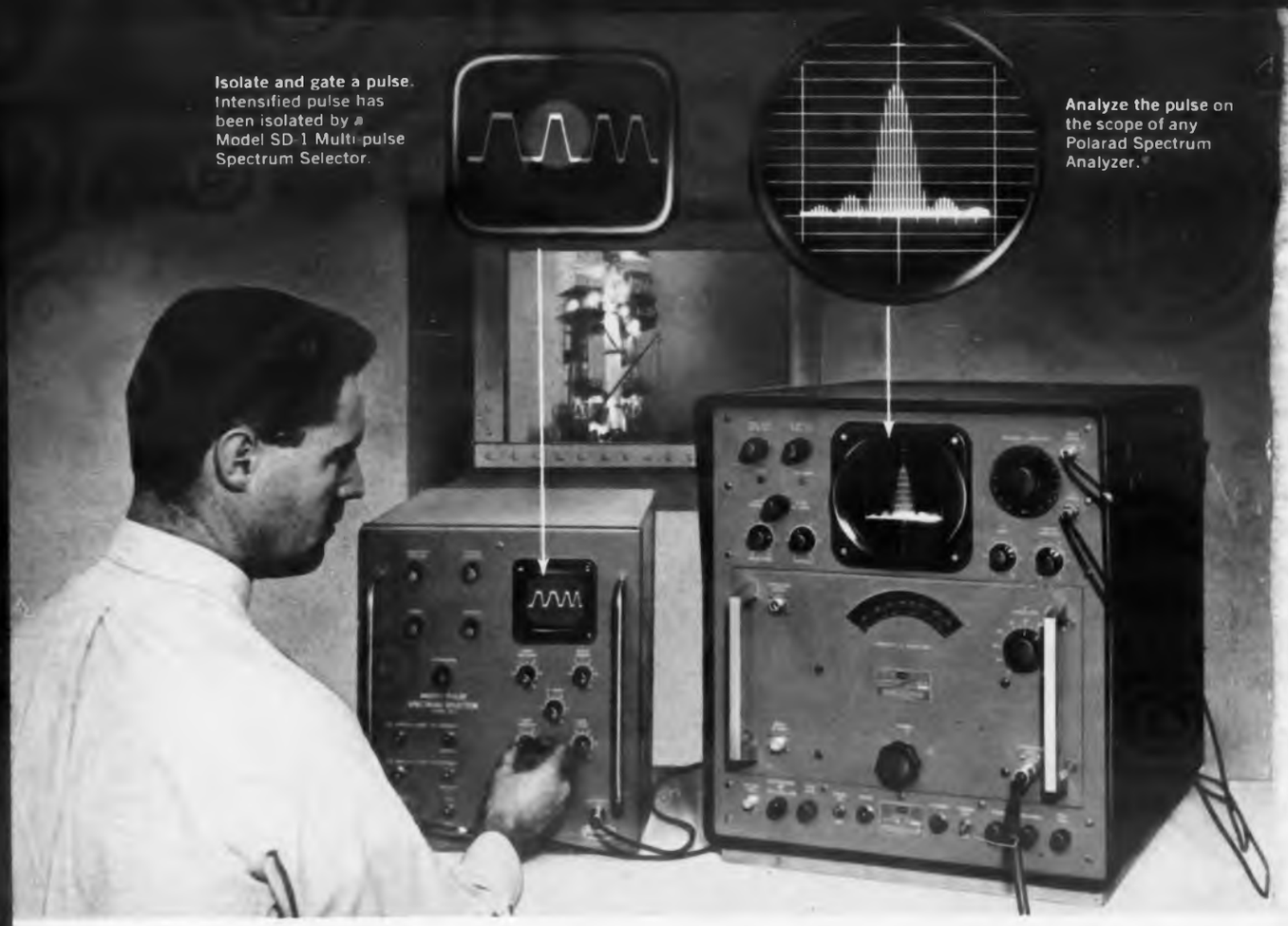
Name _____

Title _____ Dept. _____

Company _____

Address _____

City _____ Zone _____ State _____



COMPLEX SPECTRUM DECODING

10 to 44,000 mc.

Signal Analysis for Missiles, Telemetry, IFF, Beacons and Radar

The Polarad spectrum selector permits spectrum analysis and decoding of any selected pulse within a multiple pulse train. Sweep, gate width and position can be controlled. Model SD-1 permits the selection and gating of a group of pulses up to 180 μsec. in length (Model SD-1X permits 350 μsec.)

Works with POLARAD Models TSA, TSA-S, TSA-W, SA-84 and SA-84W spectrum analyzers.

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States.

BUSINESS REPLY CARD
First Class Permit No. 18, Long Island City 1, N.Y.

POLARAD ELECTRONICS CORP
43-20 34th St., Long Island City 1, N. Y.

POLARAD

MAIL THIS CARD for specifications. Ask your nearest Polarad representative (in the Yellow Pages) for a copy of "Notes on Microwave Measurements."

FREE LIFETIME SERVICE ON ALL POLARAD INSTRUMENTS

POLARAD ELECTRONICS CORPORATION

43-20 34th Street, Long Island City 1, N.Y.
Representatives in principal cities.

Power Supplies 433

Are uninterrupted type

These power supplies are for applications where there cannot be any loss of power to the load circuit. Three types of units are offered: a unidirectional system having the vital load isolated from the normal power supply, a unidirectional system having the load supplied jointly from the power system itself and the normal power supply, and a bidirectional system having the load isolated from the normal supply. A storage battery supplies power to the vital load circuit when there is a loss of power from the normal source.

Kearfott Div. of General Precision, Dept. ED, 1150 McBride Ave., Little Falls, N.J.

Medium-Power Transistors 420

Have high-frequency response

These medium-power transistors have high-frequency response, low leakage-current characteristics and the ability to remain stable over long periods while dissipating heat. They can be used in switching operations, actuating motors, driving relays or for servo, audio and pulse amplifiers. Less than 1/2 in. in diameter, the units are stud-mounted in a cold-weld package with flexible leads. They are capable of dissipating 15 w at 25 C. Type designations are 2N1658 and 2N1659.

Minneapolis-Honeywell, Semiconductor Products Div., Dept. ED, 1015 Sixth St. S., Minneapolis 4, Minn.

Price: *$6.25 and $8.30 for up to 100 units.*

Availability: *10 to 15 days.*

CIRCLE 112 ON READER-SERVICE CARD ➤
➤ CIRCLE 111 ON READER-SERVICE CARD

that makes the difference! To assure thoroughbred performance and reliability, every Saratoga Semiconductor must pass the battery of Saratoga tests.

These extra tests are employed to provide semiconductor devices for our customers which will perform under all operating and environmental conditions.

This is one more reason why the Saratoga can be called the "Thoroughbred of Semiconductors".

Send for our new catalogue SS-2001 outlining details, specifications, and applications of Saratoga silicon zener regulators and silicon power rectifiers.*

SARATOGA SEMICONDUCTOR DIVISION, Saratoga Springs, N.Y.

ESPEY MFG. & ELECTRONICS CORP.

* Meet all requirements of MIL S-19500B

At Magnetic Controls Company...

where reliability is sacred

RED/LINE timing relays "Pay Off"!

At Magnetic Controls Company, where power supply reliability is sacred, design engineers selected G-V Red/Line Thermal Relays over all others. According to Magnetic Controls, "The timing cycle does not change with ambient temperature change . . . a characteristic which is essential for maximum performance . . ." They have used the recognized quality of Red/Line in 13 different models of their power supplies without a single relay failure. That's reliability! **So, at Magnetic Controls, the high quality of G-V Timing Relays is "paying off".**

More and more companies are finding the reliable performance of G-V Red/Line Timing Relays makes them best for their products. G-V Red/Line Relays will pay off in your product, too. Your customers appreciate the importance of high quality, reliable components. G-V Red/Line Timing Relays are specially designed for industrial applications. They have the precision, reliability and long life needed to "pay off" in industrial use.

Your G-V distributor has them in stock now. Call him or write for Bulletin 131 today.

G-V

G-V CONTROLS INC.
Livingston, New Jersey

NEW PRODUCTS

Micro-Positioner 588

Is accurate to 0.001 in.

Micrometer assemblies give precise positioning in three planes on the model 200 positioner. Accuracy to 0.001 in. is standard, with 0.0001 in. and metric micrometers to special order. The range of movement is 1/2 in. in all planes. Faceplates are prepared for tool or equipment mounting.

Kulicke & Soffa Manufacturing Co., Dept. ED, 1234 Callowhill St., Philadelphia 23, Pa.
Price: *$200.*

Portable Telemetering Station 354

Model PTS-2 portable telemetering station is designed to provide a medium-accuracy, quick-look unit that is portable, yet adequate to test an entire system.

Deeco Instruments, Inc., Dept. ED, 14737 Arminta St., Van Nuys, Calif.
Price: *$11,750 ea.*
Availability: *60 to 80 days; from stock in six months.*

Analog Computer 352

Containing all the controls necessary to the operation of a 20-amplifier computer, the TR-5 mounting unit houses a transistorized power supply and up to 6 computing components. Two expansion units are available.

Electronic Associates, Inc., Dept. ED, Long Branch, N.J.
Price: *$2,767 for TR-5, 10 amplifiers, power supply, and reference regulator.*

Acrylic Fiber-Glass Sleevings 359

BS Acryl-A and BH Acryl-C acrylic resin-coated fiber-glass sleevings have flex resistances that stand severe assembly techniques without loss of rated dielectric values. The essentially neutral resin offers compatibility with wire enamels and varnishes. It will not hydrolize, soften or flow when exposed to 232 C for 15 min.

Bentley-Harris Manufacturing Co., Dept. ED, Conshohocken, Pa.
Availability: *Jan. 1, 1961.*

◀ CIRCLE 113 ON READER-SERVICE CARD

Wirewound Potentiometers 526

For missile and airborne use

These wirewound potentiometers have multigang configurations of 1/2 in. in diameter. The Acepot has a standard linearity of 0.3% and standard resistances from 100 ohms to 250 K. The Acetrim has a 3% linearity and standard resistances from 2 ohms to 250 K. Power ratings are up to 2.5 w at 65 C; operating temperature is 150 C max.

Ace Electronics Associates, Inc., Dept. ED, 99 Dover St., Somerville 44, Mass.

Availability: *2 to 3 weeks.*

Bandpass Filters 473

For frequencies up to 5 kc

The BPM filters are designed to pass frequencies of 440, 500, 600, 3,000, 4,000 and 5,000 cps. Constructed for low-level operation, they have an attenuation of 35 db per octave. Metal cased and hermetically sealed, the units meet MIL-T-27A and MIL-T-18327A. Gain is 2:1, attenuation is about 2 db ±3% from center frequency. The units measure 3/4 x 3/4 x 1-1/8 in. and weigh 1 oz.

United Transformer Corp., Dept. ED, 150 Varick St., New York 13, N.Y.

Availability: *From stock.*

Subminiature Accelerometer 662

Resonant frequency is 125 kc

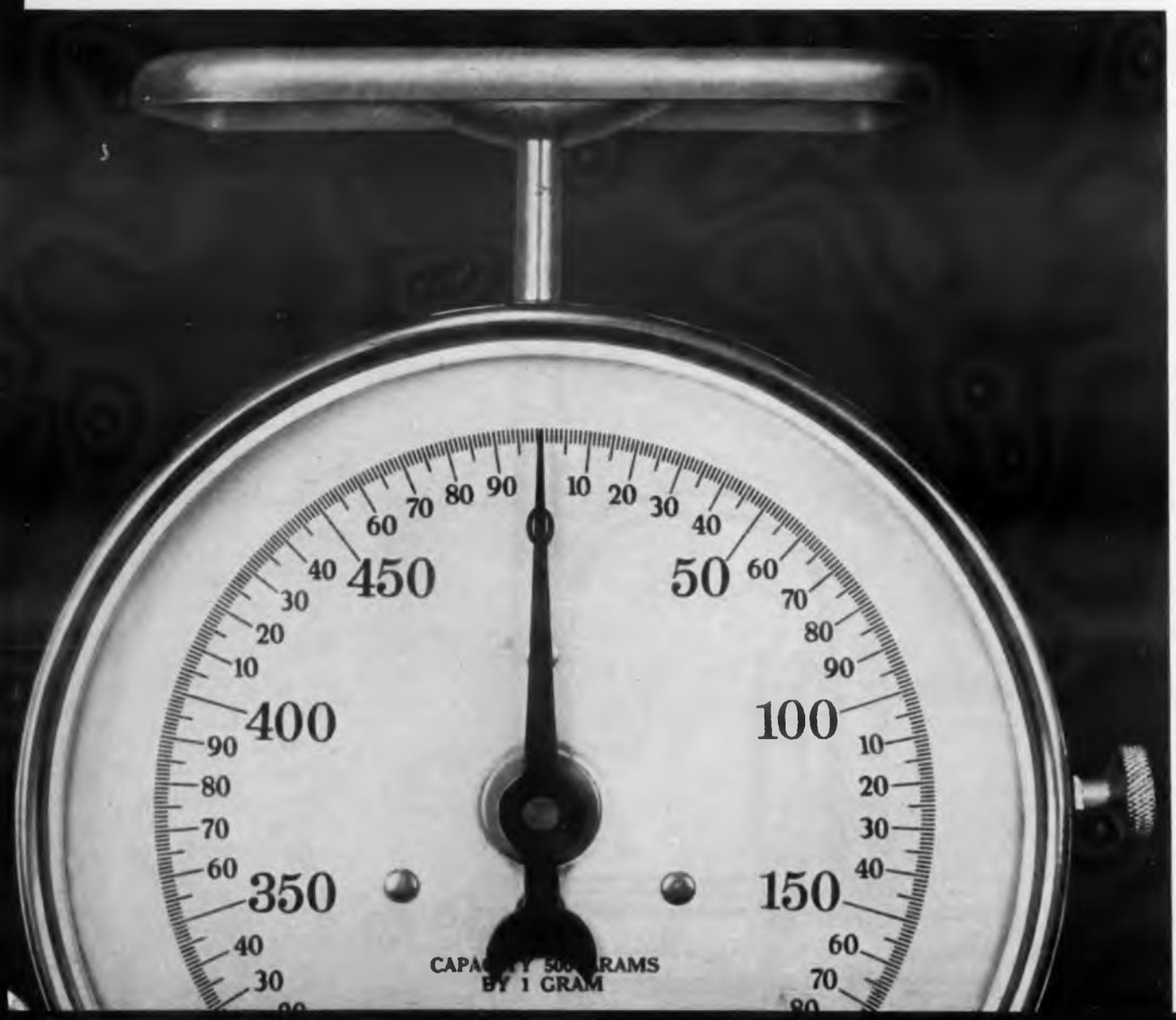
Model AA-1220 accelerometer, providing a useful frequency range to 25 kc, has a resonant frequency of 125 kc. It can be used to measure acceleration levels of up to 15,000 g. Transverse response is less than 3%. The device is suitable for applications in aircraft, military installations and industrial research. It weighs 4 g.

Gulton Industries, Inc., Dept. ED, 212 Durham Ave., Metuchen, N.J.

Price: *$265.*

Availability: *Through distributors.*

CIRCLE 115 ON READER-SERVICE CARD ➤



NEW PRODUCTS

Nylon Tape Fasteners 490

For use on cables

These nylon tape fasteners are for use on wires that have to be held together in separate groups. The device can be opened and closed at least 100,000 times without loss of holding power. It has excellent insulating properties. Widths of 0.375, 0.5 and 1-in. are available.

Velcro Corp., Dept. ED, 681 Fifth Ave., New York 22, N.Y.

***Price & Availability:** $0.40 per yd for 0.375-in. width, $0.50 for 0.5-in., and $1 for 1-in. for orders of up to 999 yd. Delivery time is 10 days.*

Format Control Buffer 381

Supplies tapes for 650, 704, 705 and 709

Model ZA-751 format control buffer accepts digitized data at random rates and processes magnetic tapes for the 650, 704, 705 or 709 computers. Input can be from analog to digital converters, time code generators, punched card readers, electric typewriters and paper or magnetic tape. Units to produce tapes for other computers can be supplied.

Electronic Engineering Co., Dept. ED, 1601 E. Chestnut Ave., Santa Ana, Calif.

***Price & Availability:** A system with 1024 character memory is $45,000; with 256 character memory, $38,500. Delivery is 120 days.*

Screen Room Filters 543

Suppress rf interference

These filters are designed for testing military and industrial equipment in screen rooms where rf interference from incoming power lines must be suppressed. Insertion loss is more than 100 db over the frequency range of 100 kc to 1,000 mc and better than 40 db to 40,000 mc. Three standard types are rated at 30, 50 and 100 amp at 250 v ac or 600 v dc.

Sprague Electric Co., Dept. ED, North Adams, Mass.

***Availability:** From stock.*

◀ CIRCLE 116 ON READER-SERVICE CARD

Temperature-Control System 660

Maintains temperatures to within 0.2 C

The British-developed A + CNS temperature-control system controls furnaces having capacities of 100 w to 100 kva for long periods, and maintains temperatures within 0.2 C at temperatures up to 1,200 C. A platinum-resistance thermometer, sealed to avoid contamination by gases, is used with an electronic controller to operate a saturable reactor for continuously variable power output to the furnace windings. Temperature errors are reduced by a factor of about 600 whether they are due to supply-voltage variations, ambient-temperature changes or varying-thermal constants.

Atkins Technical Inc., Dept. ED, 1276 W. Third St., Cleveland 13, Ohio.

Price: *$750 for complete system.*

Ceramic Magnet 476

Coercive force is 2,650 oersteds

Type F-600 ceramic magnet has a coercive force of 2,650 oersteds, an intrinsic coercive force of 3,550 oersteds and a residual induction of 2,750 gauss. The temperature coefficient of residual induction is ±0.18% per deg C. The material is particularly suitable for making stacks for periodically focused traveling-wave tubes.

D. M. Steward Mfg. Co., Dept. ED, Chattanooga, Tenn.

Modular Recording Package 477

Weighs 15 lb and measures 0.33 cu ft

This device, for test purposes and monitor control data on the SDX-5 drone program, can be used wherever memory is needed or where direct record equipment cannot be used. It is suitable for defense and civilian applications.

Leach Corp., Special Products Div., Dept. ED, Compton, Calif.

CIRCLE 117 ON READER-SERVICE CARD ➤

NEW PRODUCTS

Laboratory Magnets 478

Are general purpose assemblies

These general purpose magnet assemblies are provided with a continuously variable output power supply. The poles and pole faces are individually adjustable and replaceable. The type MHD-3 has a field density of 7,600 gauss across a gap adjustable from 1/2 in. to 3 in. Type MHD-4, with a density of 5,950 gauss, has a gap adjustable to 4 in. The magnets can be operated at double the rated current for 30 min.

MHD Research, Inc., Dept. ED, 1751 Placentia Ave., Newport Beach, Calif.

Price: *$1,825 to $2,950.*

Availability: *30 to 60 days.*

Silicone Resin Paper 362

Style No. 7601S silicone resin paper is available in gages from 0.0025 to 0.0065 in. It is suitable for operation at temperatures over 180 C. Tensile strength is 45 lb-in. in the machine direction and 16 lb-in. in the cross machine direction. Average dielectric strength is 450 v per mil. Heat resistance is 200 C continuous.

Raybestos-Manhattan, Inc., Asbestos Textile Div., Dept. ED, Manheim, Pa.

Price: *$5.60 to $7.35 per lb.*

Availability: *30 days.*

Electric Generator 479

Model GW-300 portable electric generator produces 3,000 w of ac power. It will provide packaged power on the job site or in other remote locations. It is rated at 115 or 230 v, 69 cps, single-phase.

Borg-Warner Corp., Pesco Products Div., Dept. ED, 24700 N. Miles Road, Bedford, Ohio

Price: *$575*

Availability: *From stock.*

Grounding Plate 356

This grounding plate for electronic devices weighs 1-1/4 lb. A plate measuring 6 x 2 by 1/2 in. is equivalent to 12 sq ft of copper sheeting. Use of metallic spheres fused into a rigid, porous plate permits the water to contact the area of each sphere.

Aquadynamics, Inc., Dept. ED, 6940 Farmdale Ave., North Hollywood, Calif.

Price: *$14.75 ea.*

Availability: *From stock.*

Dynamometer Equipment 374

For testing unstable section

This circuit will test induction motors in the unstable section between maximum torque and pull-up torque. It is available on fractional hp dynamometers ranging in capacity from 0.2 in. oz to 320 in. lb.

John Chatillon & Sons, Dept. ED, 85 Cliff St., New York 38, N.Y.

Price: *$160.*

Availability: *Delivery from stock.*

Subminiature Ceramic Capacitors 370

The high-capacitance Narrow-Cap line of subminiature ceramic capacitors are 5/16-in. long in values from 1,000 pf through 0.01 μf; those from 5 pf through 750 pf are 1/4-in. long max. Thickness and width are 0.095 in. on all 19 sizes.

Mucon Corp., Dept. ED, 9 St. Francis St., Newark 5, N.J.

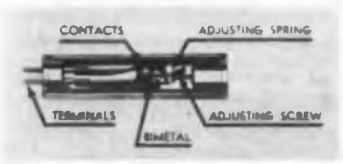
Work-Bench Modules 357

These modular components, called Flo-Line, can be rearranged, removed or added to. The bench modules can be combined to form 2- or 3-level work stations. The system offers clip-on shelves, work holders and tool holders.

Flotron Industries, Inc., Dept. ED, 1608 Centinela Ave., Inglewood 3, Calif.

Miniature Thermostat 480

Diameter is 0.317 in.



Model 292 miniature thermostat measures 0.317 in. in diameter and 1.325 in. long. It is for use in crystal ovens, oscillator compartments and computers. This hermetically sealed unit holds its control temperature to 1.5 C for over 500,000 operations with a resistive load of 0.5 amp at 26 v dc. It can handle loads up to 0.5 amp at 115 v, 60 cps, ac. Tolerance is ±1 C.

Thomas A. Edison Industries, Instrument Div., Dept. ED, 61 Alden St., West Orange, N.J.

TYPE **601PE**

Slim.. TAILORED TO TRANSISTORS

GOOD-ALL 601PE CAPACITORS are wafer thin to "fit like a disc". Capacitance is highly stable with temp. Equal in all respects to high quality Good-All tubulars. Available in 50 volt ratings only, they are competitive in price with ceramic discs in the range of .1 mfd and above. The case is moisture resisting Epoxy. Type 601PE is capable of being produced to HI-REL. specifications on a "special project basis".

SPECIFICATIONS

Insulation Resistance—Greater than 75,000 megohms when measured at 100 volts D.C. at 25° C. for a maximum of 2 minutes.

Capacity Tolerance—Standard tolerance ±20% ±10% ±5%

Winding Construction—Extended foil (non-inductive) MYLAR Dielectric.

Lead Variations—Formed or straight leads.

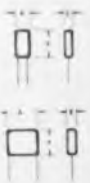
Dissipation Factor—Less than 1% at 1,000 cycles per second at 25° C.

Dielectric Strength—100 volts D.C. for 1 to 5 seconds through a minimum current limiting resistance of 100 ohms per volt.

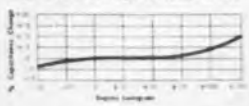
Temperature Range—May be operated at full rated voltage to 85° C. Derate to 50% when operating at 125° C.

DIMENSIONS (@ VDC Rating)

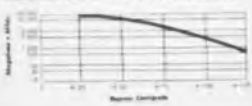
CAP. (MFD)	A	E	F
.01			
.022			
.033			
.047			
.068			
.1			
.15			
.22			
.33			



Capacitance Change vs. Temperature



Insulation Resistance vs. Temperature



Good-All CAPACITORS

Write for detailed literature

GOOD-ALL ELECTRIC MFG. CO. Ogallala, Nebr.

CIRCLE 122 ON READER-SERVICE CARD

THIS SLIM-LINE, TRIM-LINE STYLIST

Have a look at the most distinctively different meter design in years. Start with styling (as your customers do): note the thoroughbred leanness, the crisply drawn detail, the overall look of precision. Consider function: see how the picture-window dial is recessed and angled back for easier reading. Ponder practicality: observe that the self-trimming case is installed with just a single panel cutout. Sample the specifications: choose from two sizes—Model 561, 5" x 2⅞", and Model 361, 3½" x 2"; both in satin-finish Bakelite; both available in standard microampere, ampere, millivolt and volt ranges, AC or DC. Prices and other data? Ask for Bulletin 107.

ASSEMBLY PRODUCTS, INC.
Chesterland 17, Ohio

E.A. 2110

CIRCLE 123 ON READER-SERVICE CARD

NEW PRODUCTS

Panel Instrument Meters 529

Available in dc, rf and ac-rectifier types

The 301 series panel instrument meters are available in dc, rf, moving-iron ac and ac-rectifier types. Accuracy is 2% of full scale. The 302 to 307 series, ac-rectifier types, have accuracies to within 3% of full scale on wave forms closely approximating the sine wave at room temperature.

Daystrom, Inc., Weston Instruments Div., Dept. ED, 614 Frelinghuysen Ave., Newark 12, N.J.

Translator Systems 541

Four types offered

These transistorized units are for use with ac electromechanical transducers, including variable permeance, differential transformer, resistive bridge and other ac sensing devices. They sense changes in an ac transducer output, amplify and convert these changes into proportional dc signals for direct indication or recording. Gain is 100, nominal. Types 83F and 85F use a 3-kc oscillator frequency; types 83N and 85N use a 10-kc oscillator frequency.

Crescent Engineering and Research Co., Dept. ED, 5440 N. Peck Road, El Monte, Calif.
Price: *Type 85F without rack, $585.*
Availability: *From stock.*

Transducer Calibration System 569

Measures 5-1/4 x 9-1/2 x 20-1/2 in.

Model 1028 transducer calibration system performs these seven functions: dc amplification with a 70-kc bandwidth; isolated dc amplification with 10-meg input-to-

CIRCLE 124 ON READER-SERVICE CARD

output isolation; precision demodulation; frequency to dc conversion, with 0.5% linearity from 100 to 1,000 cps; transducer excitation supplied with 0.02% accuracy; five-step calibration with 0.03% accuracy; and transducer matching.

Epsco-West, Dept. ED, 240 E. Palais Road, Anaheim, Calif.
Price: *Dependent on configuration.*
Availability: *45 days.*

Trimming Potentiometers 544

Meets Mil specs

Models 50 and 60 trimming potentiometers have humidity-proof construction in accordance with MIL-STD-202A, Method 104, Condition A and MIL-E-5272C, Proc I. Model 50 is 3/8 in. sq and comes in ranges of 50 ohms to 20 K. It is rated at 1 w at 50 C and weighs 1 g. Model 60, measuring 1/2 in. sq and weighing 2 g, is rated at 2 w at 40 C and is available in ranges from 50 ohms to 50 K. Both units can be furnished with different terminal types and adjustment-screw configurations.

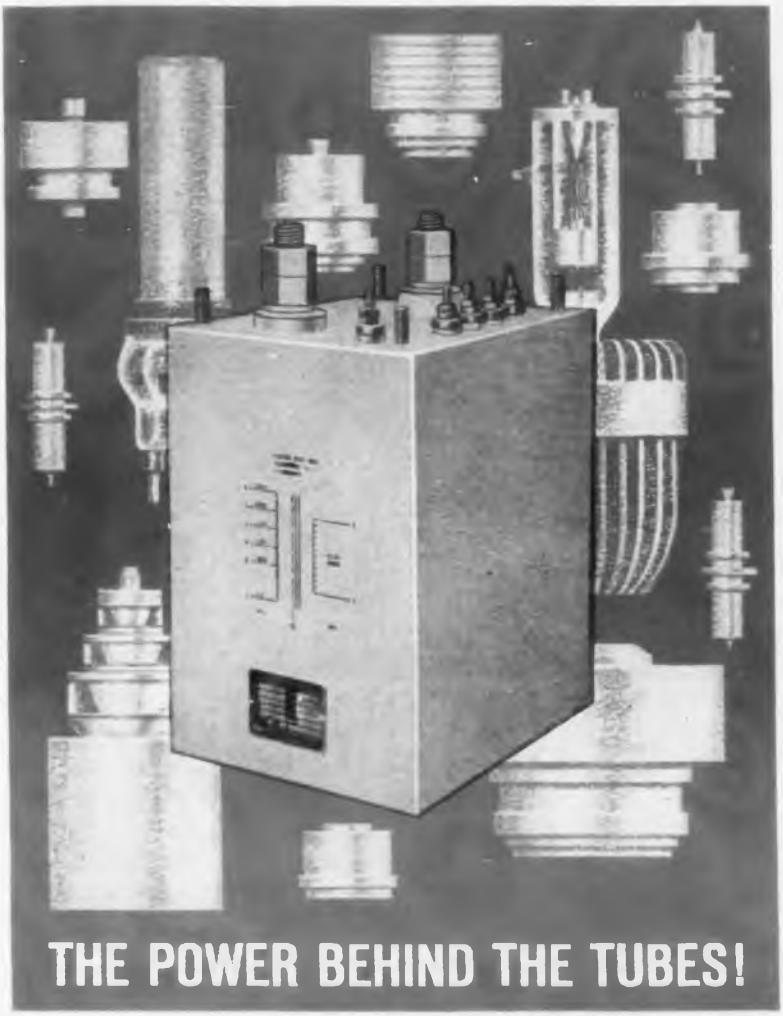
Spectrol Electronics Corp., Dept. ED, 1704 S. Del Mar Ave., San Gabriel, Calif.
Price: *$6.*
Availability: *Immediate, through distributors.*

Power Supplies 564

For traveling-wave tubes

These power supplies furnish all voltages required for operating traveling wave tubes. Beam, control bias, and one or more magnet dc and heater ac voltages are supplied. The outputs are adjustable from zero to the rated maximum. Typical outputs are: 0 to 4000 v dc at 1 amp, beam; 0 to 300 v dc at 50 ma, bias; 0 to 220 v dc at 8 amp, magnet; and 0 to 15 v ac at 15 amp, heater.

Sorensen & Co., Dept. ED, Richards Ave., South Norwalk, Conn.



THE POWER BEHIND THE TUBES!

NWL HIGH FREQUENCY FILAMENT TRANSFORMERS

Here is the latest addition to the well-known family of NWL custom-built transformers. Illustrated is a special high frequency, high reactance filament transformer with an output of 11.5 volts at 700 amps, 400 cycles, single phase. The unit is hermetically sealed for shock-proof and high humidity operation.

Each NWL unit is thoroughly tested and must meet all customer requirements before shipment. We shall be pleased to quote you according to your individual requirements.

NWL

ESTABLISHED 1920

NEMA

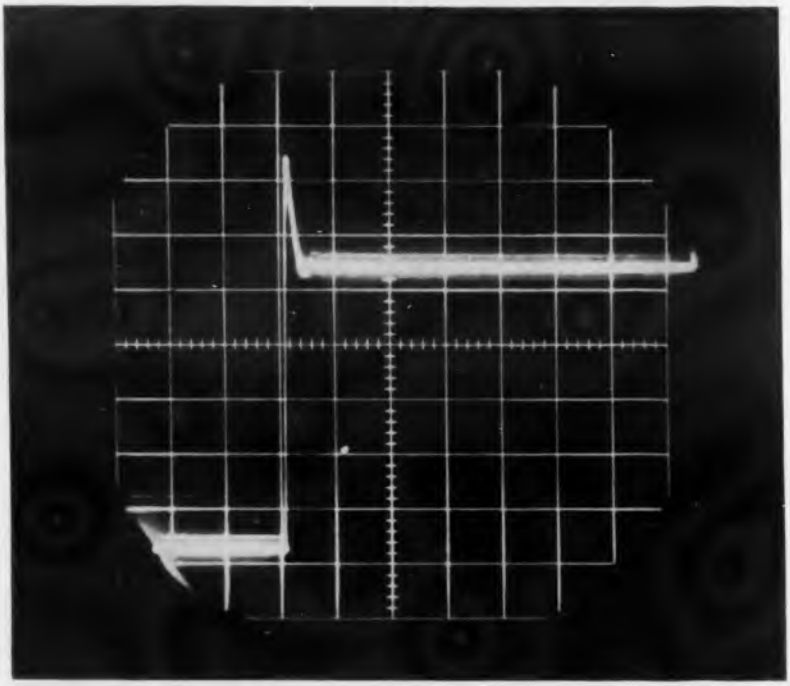
Nothelfer

SAY: NO—TEL—FER

NOTHELFER WINDING LABORATORIES, INC., P. O. Box 455, Dept. EN-1, TRENTON, N.J.

(Specialists in custom-building)

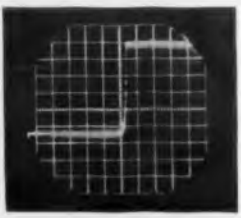
CIRCLE 126 ON READER-SERVICE CARD



TRANSISTOR-KILLER: THE VOLTAGE SPIKE

TAMED BY PERKIN MTR DC POWER SUPPLIES

The "turn-on" transient above could destroy the transistors in your circuit in microseconds. Protect transistorized equipment against treacherous line and load transients with Perkin MTR tubeless power supplies. Combining the best of two solid-state regulation principles, they use magnetic amplifiers for high efficiency and transistors for instantaneous suppression of transients and ripple. No tubes, no moving parts, no trouble! Units sustain shorts and overloads indefinitely, resuming normal operation automatically. Ideal for continuous-duty and unattended operation. Prompt delivery anywhere.



HERE ARE JUST A FEW OF OUR MANY OFF-THE-SHELF UNITS
WRITE FOR COMPLETE CATALOG

Model No.	D.C. Output		Static Regulation		Dynamic Regulation		A.C. Input 60 cps, 1 Phase	Ripple RMS
	Volts	Amps	Line	Load	Line	Load		
MTR036-5	0-36	5	±10MV	±10MV	±10MV	±.2V	105-125V	1MV
MTR036-15	0-36	15	±10MV	±10MV	±10MV	±.2V	105-125V	1MV
MTR636-15	6-36	15	±25MV	±50MV	±25MV	±.75V	105-125V	5MV
MTR636-30	6-36	30	±25MV	±75MV	±25MV	±.85V	105-125V	5MV
MTR28-5	24-32	5	±0.1%	±0.1%	±0.1%	±.3V	105-125V	5MV
MTR28-10	24-32	10	±0.1%	±0.1%	±0.1%	±.4V	105-125V	2MV
MTR28-30	24-32	30	±0.1%	±0.1%	±0.1%	±.5V	105-125V	5MV

Representatives in Principal Cities

PERKIN
ELECTRONICS CORPORATION
345 Kansas Street, El Segundo, California ☐ SPring 2-2171

CIRCLE 127 ON READER-SERVICE CARD

NEW PRODUCTS

Control Units 481

For servo systems

These precision-geared digital display control units, for introducing voltage settings into servo systems, are available in a wide selection of single and dual speed synchros, potentiometers, or shaft encoders. The units, contained in 2-in. diam sealed cases, meet Military specs.

Servo Development Corp., Dept. ED, 2 Willis Court, Hicksville, L.I., N.Y.
Price: *$100 to $500.*
Availability: *From stock.*

Copper-Clad Plastic Laminate 482

Type XXXP-36RE reinforced laminate is suited for printed-circuitry applications where heavy components are used. Flexural strength, crosswise and lengthwise, is 17,000 and 24,000 psi.

Formica Corp., American Cyanamid Co., Dept. ED, 4532 Spring Grove Ave., Cincinnati, Ohio.

Mounting Systems 483

These mounting systems are designed to combine various pieces of airborne electronics equipment onto one base. High-frequency vibration and shock are attenuated. Integral cooling of the mounted modules and electrical connections are provided. Military specifications are met.

Lord Manufacturing Co., Dept. ED, Erie, Pa.

Placard Indicator Assembly 484

For special applications

Model C6-121 placard indicator assembly is for special panel design applications. The unit measures 4-3/4 x 1-5/16 in. It has a one-piece removable lens for front-of-panel lamp insertion, four message areas, four separate lamps and lamp circuits, and black plastic lens housing. The face lens is black when not illuminated.

Controls Co. of America, Control Switch Div., Dept. ED, 1420 Delmar Drive, Folcroft, Pa.

Phase-Angle Voltmeter 474

All-transistor, militarized unit

Model VM-230 phase-angle voltmeter is an all-transistor, militarized unit. It is for modular inclusion in military ground support, flight-test and mobile-field instrumentation systems. The unit combines the functions of an ac voltmeter, phase meter, phase-sensitive null indicator, power-factor meter and a meter that measures separately the in-phase and quadrature components of a signal. For 115-v, 400 or 800-cps operation, this unit provides 12 ranges of voltage measurement, covering 1 mv to 300 v full scale. Accuracy as a phase-angle voltmeter is ±3% of full scale; as an ac voltmeter it is ±2% of full scale.

North Atlantic Industries, Inc., Dept. ED, Terminal Drive, Plainview, L.I., N.Y.

DC to DC Inverter 458

Input is 26 v

Model MAC26-4-2 dc-to-dc inverter, hermetically sealed, has an input of 26 v and an output of 450 v at 190 ma. Ripple can be as low as 0.10%. The unit measures 3-9/16 x 3-1/16 x 3-7/8 in.

Freed Transformer Co., Inc., Dept. ED, 1718 Weirfield St., Brooklyn 27, N.Y.
Price: *$103.*

Transducer Scanning System 542

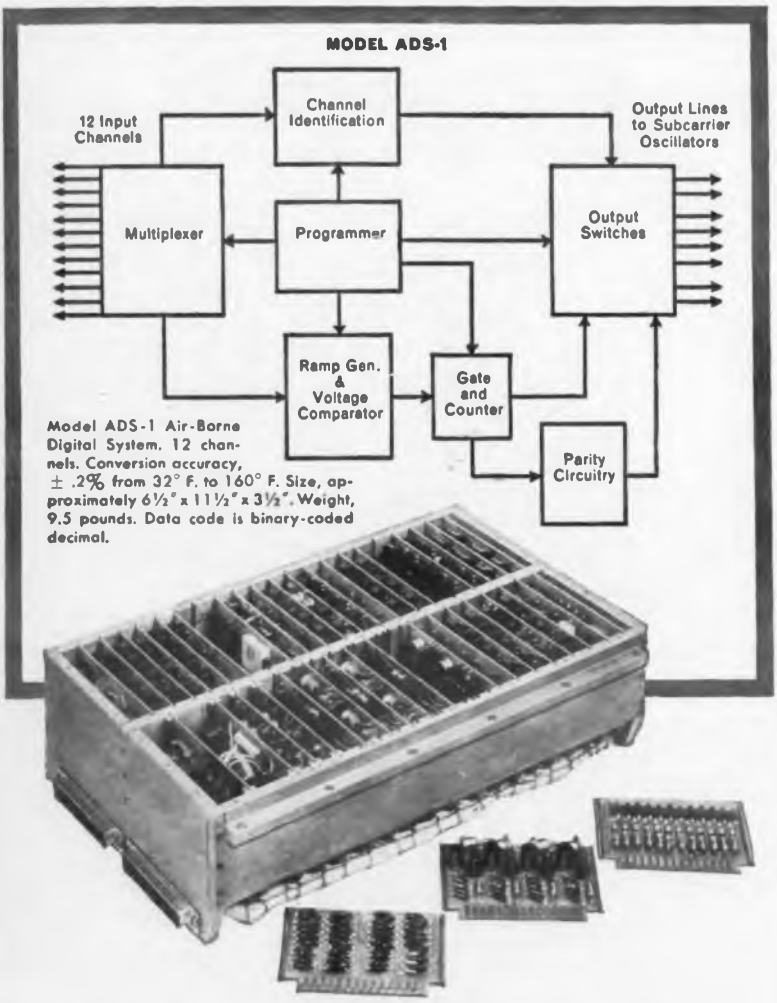
Monitors multiple signals

This scanning system automatically monitors multiple signals from a group of transducers that sense conditions such as temperature or pressure. No mechanical switching components are used. The one-unit system measures 3 in. long and weighs less than 0.6 lb.

Simmonds Precision Products, Inc., Dept. ED, 105 White Plains Rd., Tarrytown, N.Y.
Availability: *120 days.*

CIRCLE 129 ON READER-SERVICE CARD ▶

DIGITAL DATA SYSTEMS



An air-borne digital system that is small, rugged, accurate, low in cost

Typical of Curtiss-Wright digital systems is Model ADS-1, designed primarily for missile use. It converts multiplexed analog voltages to a digital equivalent for use with FM-FM Telemetry Systems, magnetic or paper tape recorders. System includes input multiplexing, an analog to digital converter, output switching, channel identification and parity checking. Composed entirely of solid state components, except for 12 electromechanical input switching relays. Ideal also for ground instrumentation, industrial quality control, development laboratories. Special systems custom-designed to meet your specific requirements. Blueprint your problem and let us suggest an answer.

Inter Mountain Instrument Branch — Electronics Division

CURTISS WRIGHT

CORPORATION • P.O. Box 8324, Albuquerque, New Mexico

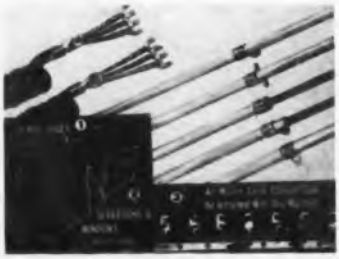
SOLID STATE RELAYS • SINGLE TRANSIENT PEAK READING VOLTMETERS • TRANSISTOR TEST INSTRUMENTS AND SYSTEMS • DIGITAL DATA ACQUISITION AND PROCESSING SYSTEMS

CIRCLE 130 ON READER-SERVICE CARD

NEW PRODUCTS

Cord Clamps 355

For automatic crimping



Strain relief and anti-fray cord clamps are available in chain form for automatic crimping. The clamps, of brass or aluminum, are supplied in rolled strips to feed a bench-mounted crimping machine which handles all types of clamps.

Malco Manufacturing Co., Dept. ED, 4025 W. Lake St., Chicago 24, Ill.

Gear Tuner 377

These units are suitable for magnetron and klystron tuning, variable condensers, potentiometers and coils. They can also be used as hand operated inputs to mechanical equipment. Normal ratio is 19.5:1, but special units can be furnished.

Illinois Tool Works, Spiroid Div., Dept. ED, 2501 N. Keeler Ave., Chicago 39, Ill.

Vinyl Insulation Material 373

Vyna-Kote liquid vinyl is for use in custom wiring and harness operations. It is applied by brush or dipping and dries almost instantly. The resultant film is a high-quality insulation.

Spectra-Strip Wire & Cable Corp., Dept. ED, P. O. Box 415, Garden Grove, Calif.

Transistorized Drive Amplifier 488

For dc torque motors

Model 910 transistorized drive amplifier, for dc torque motors, delivers 2 amp dc into a two-terminal torquer. Input can be dc or 400 cps. Gain is 200 mv per 1-amp dc output current. The unit operates from standard 28 v dc power and uses 400 cps for reference. Operating temperature is −55 to +71 C. It meets MIL-E-5272 specs.

Control Technology Co., Inc., Dept. ED, 1186 Broadway, New York 1, N.Y.

Availability: *Two weeks.*

Computer Diode 645

Recovery time is 0.5 nsec

This gold-bonded silicon diode has a guaranteed recovery time of 0.5 nsec. In development tests, the computer diode switches from 10-ma forward current to —6 v reverse voltage in 0.2 nsec. Typical capacitance for the diode is 0.7 pf. It has a rectification efficiency of 25% at 13.5 Gc. Five units, designated types HD5000 through HD5004, are offered.

Hughes Aircraft Co., Semiconductor Div., Dept. ED, 500 Superior Ave., Newport Beach, Calif.
Price: *$1.17 to $2.60 in lots of 100.*
Availability: *Immediate.*

DC Elapsed-Time Indicator 525

Accurate to 1%

The "Alert" dc elapsed time indicator meets MIL-E-5272C specs at: temperature, from —65 to +160 F; altitude, 100,000 ft; vibration, 10 to 500 cps at 10 g. It measures 1 in. in diameter by 1-1/4 in. deep and weighs 2 oz. The unit operates on 20 to 30 v dc; 1,000 and 10,000-hr models are available.

Houston Fearless Corp., Houston Fearless Div., Dept. ED, 11800 W. Olympic Blvd., Los Angeles 64, Calif.
Price: *$150 ea.*
Availability: *Jan. 1, 1961.*

Transistor Heat-Dissipating Retainer 475

Accommodates three diameter variations

The rivet- and screw-attaching type heat-dissipating retainers provide maximum thermal contact with the transistor case. The beryllium-copper, spring-finger construction accommodates diameter variations from 0.305 to 0.335 in.

International Electronic Research Corp., Dept. ED. 135 W. Magnolia Blvd., Burbank, Calif.
Price: *36 cents to 75 cents.*
Availability: *From stock.*

CIRCLE 132 ON READER-SERVICE CARD ▶

engineers... REMEMBER!

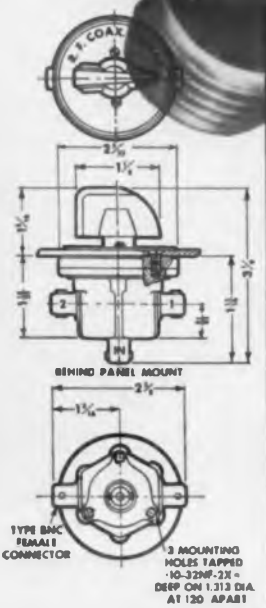
when specifying

COAXIAL SWITCHES

GCC Has the ANSWER to your COAXIAL SWITCH requirements.
GCC is the OLDEST MANUFACTURER of COAXIAL SWITCHES.
GCC offers the MOST COMPLETE ... the MOST VERSATILE line of COAXIAL SWITCHES.
GCC offers MINIATURE COAXIAL SWITCHES for special applications.
GCC offers MANUAL, MOTORIZED, and RELAY OPERATED COAXIAL SWITCHES.
GCC INVITES your SWITCHING QUERIES.
GCC offers COMPLETE ADVISORY SERVICE.
GCC COAXIAL SWITCHES provide the HIGH RELIABILITY, LOW INPUT IMPEDANCE, LOW VSWR, LONG LIFE, LOW CROSSTALK.

OPERATING CHARACTERISTICS OF MODEL 2BN180MC

1. **Frequency Range** 0 to 10,500 Megacycles
2. **R. F. Characteristic Impedance** 51.0 Ohms
3. **Voltage Standing Wave Ratio** ... 1.2:1 at 3,000 Megacycles
4. **Insertion Loss** 0.1 DB at 3,000 Megacycles
5. **Crosstalk (Interchannel Attenuation)** ..... 60 DB below operating level at 3,000 Megacycles
6. **R.F. Voltage Rating** 500 volts peak
7. **R.F. Power Rating** ..... 100 Watts Avg. at 3,000 Megacycles
8. **Operative Life** 10,000 Cycles minimum
9. **Insulation Resistance** ..... Greater than 500 megohms at 500 V.D.C.
10. **R.F. Connector** ..... Type BNC (50 ohm) equivalent of UG-291/U
11. **Connecting R.F. Cables** ..... 50 ohm coaxial cables with type BNC connector
12. **Rotor** Non-shorting
13. **Circuit** Single pole –2 position at 180°
14. **Operating Temperature Range** ..... –55° to +55° centigrade
15. **Weight** 14 ounces



Write us for our catalog including Form SE-100 for your convenience in describing your specific requirements for COAXIAL SWITCHES.

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677 Beacon Street
Boston 15, Mass.

creative electronics

We are also engaged in Research and Manufacturing in the following fields:
RADAR TEST SETS, RADAR BEACONS, SIGNAL GENERATORS, AND PRIMARY STANDARDS FOR FREQUENCY, VOLTAGE AND PULSE POWER CALIBRATION

CIRCLE 133 ON READER-SERVICE CARD

NEW PRODUCTS

Magnesium Oxide 549

Rare-earth doped

Magnesium oxide crystals, doped with praseodymium, samarium, and neodymium oxides, are available in single and polycrystalline specimens. Single crystals are 1 to 3 mm in cross section, and 4 mm or more in length. Polycrystalline specimens may be much larger.

Semi-Elements, Inc., Dept. ED, Saxonburg Blvd., Saxonburg, Pa.

Price: *$20.*

Level Control 537

15 μa sensitivity

Deionized water will complete the 15-μa probe circuit of this transistorized level control. The system has single point or differential control, adjustable sensitivity, and thermistor temperature compensation. No moving parts contact liquid. The control unit has a spdt, 15-amp relay.

Precision Thermometer & Instrument Co., Dept. ED, 1434 Brandywine St., Philadelphia 30, Pa.

Price: *$70, less probes.*

Counting System 548

Accepts 120-μsec pulse

This packaged counting system will accept an input pulse as short as 120 μsec. It has a counting rate of 3,000 cpm, instant reset, and a life cycle of 100,000,000 counts. Called the Count/Pak, the system is equipped with a photo-electric pickup. A wide variety of other pickup devices may be used.

Veeder-Root, Inc., Electronic Controls Div., Dept. ED, Danvers, Mass.

Price: *$165.*

Availability: *From stock.*

Power Transistor 497

Will dissipate 150 w

The 2N1358 will dissipate 150 w, and has a maximum thermal resistance of 0.5 C per w. Housed in a lugged version of the low silhouette TO-36 package, the 80-v, 15-amp unit is rated for junction operation up to 100 C.

Motorola Semiconductor Products, Inc., Technical Information Center, Dept. ED, 5005 E. McDowell Road, Phoenix, Ariz.

Price: *$18 ea, 1 to 99; $12 ea, 100 and up.*

Vibration Monitors 556

Completely transistorized

Completely transistorized, models V/p-2 and V/p-T are designed for vibration indication and protection. The ac operated model V/p-2 has ranges of 0 to 0.1 mils, 0 to 1 mils and 0 to 10 mils. It has the capability to measure amplitudes below 10 μin. and to detect changes of 1 μin. Model V/p-T operates on 48 of 60 v dc and is designed for pipeline service.

Indikon Co., Dept. ED, 76 Coolidge Hill Road, Watertown 72, Mass.

Price: *Model V/p-2, $320; model V/p-T, $468.*

Flight Programer 554

This flight programer is designed for unmanned research balloons. It will terminate balloon flight if altitudes of 2,500 or 44,000 ft are not attained within a predetermined period of time, or if the balloon should descend below 44,000 ft during the flight. The device weighs less than 1.5 lb, and provides timing accurate within 1.5 min per day.

C. T. Schjeldahl Co., Dept. ED, Northfield, Minn.

Alpha Numeric Readout 559

Accepts any BCD code

The Bina-View alpha numeric readout accepts any BCD code up to six bits, does its own translating and displays the proper character. It operates with as little as 10 mw per bit of signal power and will display up to 20 characters per sec. It is 3-1/4 in. high x 1-3/4 in. wide and 6-3/4 in. long. Weight is approximately 2 lb.

Industrial Electronic Engineers, Inc., Dept. ED, 5528 Vineland Ave., North Hollywood, Calif.

Price: *$50 ea.*

AEROVOX
CAPACIBILITY*

FOR MINIMUM SIZE...
MAXIMUM RELIABILITY...

AEROTAN®
SOLID TANTALUM CAPACITORS

AEROTAN TECHNICAL FACTS

Aerotan capacitors are applicable in DC blocking, AC coupling, bypass and filtering, integration, storage phasing and timing applications.

Manufactured in uninsulated case styles (ST12) and insulated cases (ST13).

Designed for continuous operation over temperature range of −80°C to +125°C in voltage ratings shown below:

Rated Voltage	+65°C	+85°C	+125°C
6 VDC	6 VDC	6 VDC	4 VDC
10 VDC	10 VDC	10 VDC	7 VDC
15 VDC	15 VDC	13 VDC	10 VDC
20 VDC	20 VDC	17 VDC	13 VDC
35 VDC	35 VDC	28 VDC	20 VDC

No compromise is necessary here—now, you can assure maximum reliability without bulk by specifying Aerovox Aerotan solid tantalum capacitors.

Aerotan capacitors are housed in hermetically sealed metal cases and feature a semiconductor electrolyte assuring a completely dry assembly with absolute freedom form corrosion or leakage.

For all those space- and weight-saving needs where only the best in reliability will do—specify Aerovox Aerotan, and be **sure.**

Write for complete technical information

*CAPACI-BILITY
An Aerovox characteristic. Capability to design, develop, and manufacture capacitors to best meet customers' requirements.

AEROVOX CORPORATION

NEW BEDFORD, MASS.

CIRCLE 136 ON READER-SERVICE CARD

NEW PRODUCTS

Cathode Ray Tube 589

Dual-beam, 5-in. tube

Type 5CWP cathode ray tube is a 5-in., dual-beam tube. Specifications include: post accelerator voltage, 8,000 v; accelerator voltage, 3,000 v; deflection factors, 65 to 85 v dc per in. and 45 to 65 v dc per in.; deflection factor uniformity, 2% max; pattern distortion, 3% max; tracking error, 0.06 in. max.

Fairchild Camera and Instrument Corp., Allen B. Du Mont Labs. Div., Electronic Tube Div., Dept. ED, 750 Bloomfield Ave., Clifton, N.J.

Insulating Tape 594

This polyurethane foam insulating tape, called Arnofoam, is available in thicknesses of 1/8 in. (C-901), 1/4 in. (C-902) and 1/2 in. (C-903). Adhesion to steel is 75 oz per in. width and compression strength is 1-1/2 psid. Continuous temperature limit is 260 F and intermittent limit is 300 F.

Arno Adhesive Tapes, Inc., Dept. ED, Michigan City, Ind.

Serialization Marker 491

These markers are designed for the serial identification of miniature and subminiature components on matrix boards and circuit cards. The self-adhering markers, measuring 1/16 x 3/16 in., comply with MIL-I-15024A.

Western Lithograph Co., Westline Products, Dept. ED, 600 E. 2nd St., Los Angeles, Calif.

Availability: 2 to 3 weeks after order.

Aluminum Foil Tape 492

This 1-mil aluminum foil tape, No. 7452, backs an insulating rubber resin adhesive. Available in 1 in. or 2 in. rolls.

Mystik Adhesive Products, Inc., Industrial Div., Dept. ED, 2635 N. Kildare Ave., Chicago 39, Ill.

Terminal Kit 493

An assortment of over 500 lugs, clips, and terminals is available in a transparent-lidded plastic box. Lugs and terminals are pre-tinned.

Ziereck Manufacturing Corp., Dept. ED, 110 Beechwood Ave., New Rochelle, N.Y.

Price: $2.00.

Strain Gage Transducer 595

Weighs 0.5 g

Claimed to be the smallest known strain gage transducer, the model P318 is a flush-diaphragm, absolute pressure type weighing 0.5 g. Diameter is 0.59 in.; thickness is 0.050 in. Ranges are 0 to 10 psi to 0 to 100 psi, available in absolute, gage, or differential. Excitation is 15 v; output is 5 mv, full scale open circuit. Total error is said to be less than 1% of full scale. Ambient temperature range is —65 F to 150 F.

Statham Instruments, Inc., Dept. ED, 12401 W. Olympic Blvd., Los Angeles 64, Calif.

Dual Centrifuge 494

Has satellite table

The model DC-4 dual centrifuge has a fixed satellite turntable mounted on a large turntable. Absolute angular velocity of the small table is independently controlled. The main table operates at up to 500 rpm; satellite table speeds are variable from 0 to 1,800 rpm. The machine provides steady acceleration from 0 to 100 g, and a range of sinusoidal frequencies from 0 to 30 rps. Rated load is 2.5 lb for the satellite table and 5 lb for the main table. The machine draws 3 kw at 220 or 440 v, 60 cps, single or 3-phase, and weighs about 1,200 lb.

Schaevitz Engineering, Dept. ED, Rte. 130 at Schaevitz Blvd., Pennsauken, N.J.

Radiant Ovens 495

These radiant ovens meet temperature tolerances with heaters placed on all six sides of the chamber. Heated aluminum shelves for applying direct heat to the work are optional.

Temperature Engineering Corp., Dept. ED, Riverton, N.J.

***Availability:** 10-day delivery from stock.*

High Purity Lead 496

This semiconductor grade lead, 99.999+% pure, is free of Group 3B and Group 5B elements, and is said to contain less than 1 part per million of copper or silver. Available in bars or special shapes.

Alpha Metals, Inc., Dept. ED, 56 Water St., Jersey City 4, N.J.

***Price:** $4 per lb in 50-lb quantities.*

***Availability:** Five days.*

H-LAB REGULATED POWER SUPPLIES

NEW Plug-In Card Selects Mode of Operation

- Constant voltage or constant current operation
- Units can be combined in series and parallel
- Printed card makes all internal wiring changes
- Continuously variable output voltage and current
- No overshoot on turn-on or turn-off
- No moving parts

H-Lab Model 808A is a versatile compact constant voltage/constant current transistor power supply possessing a combination of features that make it a truly unusual and exceptional power supply. All internal wiring changes for adaptation to constant voltage, constant current, auto series, and auto parallel modes of operation are accomplished by simply inserting one of the several plug-in printed circuit cards provided with the 808A supply.
The model 808A also features a continuously adjustable current limit control located on the front panel. The output current will not exceed the preset current limit value under any load conditions including a short circuit. This fast acting, adjustable protection circuit not only provides full protection for the power supply, but gives optimum protection to the load device as well.

For more stringent regulation requirements, chopper-stabilized Model 808AX is available. H-Lab Model 808A is priced at **$475**

SPECIFICATIONS

Output: 0-36 volts, 0-5 amps.
Constant Voltage or Constant Current
Input: 105-125 VAC 60 cps
Load Regulation:
Constant Voltage 0.01% or 3.6 mv
Constant Current 0.1% or 5 ma
Ripple:
Constant Voltage 500μv rms
Constant Current 3 ma rms
Size: 3½" H x 16¾" D x 19" W

Remote Programming • Remote Sensing
Short-Circuit Proof

OTHER PRECISE, VERSATILE AND COMPACT POWER SUPPLIES INCLUDE:

Model	E Out	I Out	Bench Model	Rack Model	Continuously Variable	Special Comments	Price
400D	150-315	0-1.5		X	No	Vacuum Tube Type	$595.00
520A	0-36	0-20		X	Yes	High Efficiency	575.00
800A-2	0-36	0-1.5	X	X	Yes	Dual Output	580.00
800B-2	0-36	0-2.5	X	X	Yes	Low Cost Medium Current Supply	339.00
802B	0-36	0-1.5		X	Yes	Dual Output Remote Sensing	580.00
805AM	0-20	0-2.0		X	Yes	Remote Sensing Remote Programming	350.00
810A	0-50	0-7.5		X	Yes	Remote Sensing	895.00
812C	0-32	0-10		X	No	Remote Sensing	590.00
855	0-18	0-1.5	X	X	Yes	Can be connected in series or parallel	175.00
865	0-40	0-0.5	X	X	Yes	Continuously Variable Current Limit	185.00
880	0-100	0-1.0	X	X	Yes	Wide Voltage Span	375.00

Write on your letterhead for new, illustrated catalog describing the complete H-Lab line.

H-LAB **HARRISON LABORATORIES, INC.**
45 Industrial Road • Berkeley Heights, New Jersey

CIRCLE 139 ON READER-SERVICE CARD

NEW PRODUCTS

Wireless Microphone 643

Weighs 7.5 oz

Weighing 7.5 oz and measuring 1 in. in diameter and 5-in. long, the Vega-Mike is a completely self-contained miniature fm broadcast station with transistors and battery. Exterior design is similar to that of a lavalier microphone. The neck strap acts as an antenna element. Power output is 0.02 w, useful range is 1/2 mile or more and operating frequencies are 25 to 45 mc.

Vega Electronics Corp., Dept. ED, 10781 N. Highway 9, Cupertino, Calif.

Price: *$249.75, receiver, $267.75; complete system $495.*

Linear Potentiometer 550

Detects 0.000005 in.

Model 111 linear-motion potentiometer detects motions as small as 0.000005 in. Life rating is up to 30,000,000 strokes. The unit operates with an ac or dc input and provides outputs up to 250 v per in. displacement without amplification. Resistance range is 250 ohms to 125 K per in. of stroke, wattage is 1 w per in. of stroke, temperature range is —55 to +150 C, and stroke lengths are 1/4 to 10 in.

Computer Instruments Corp., Dept. ED, 92 Madison Ave., Hempstead, L. I., N.Y.

Availability: *Delivery time is 30 days.*

Frequency Standard 551

Output is 400 cps ±10 ppm

Type MB400 frequency standard has an output of 400 cps ±10 ppm, a square wave at 2 v min, peak-to-peak, into a 1-K load. A master clock type of instrument, the unit is suited for use in missile guidance.

It stands temperatures from −20 to +71 C, vibration of 5 to 2000 cps at 15 g, and up to 100-g shock in all directions. It is housed in a hermetically sealed can measuring 2 x 2 x 4.25 in., has an internal oven, and uses silicon devices throughout.

Bulova Watch Co., Inc., Dept. ED, 40-01 61st St., Woodside 77, N.Y.

Price & Availability: *Price is $825 ea for one or two units, $685 ea for three to ten units. Delivery requires 10 to 12 weeks.*

Silicon Rectifiers 648

Replace vacuum tubes

Rated at 1,250-v piv at 80 ma dc, type ST-8 rectifier replaces vacuum tubes 0Z4 and 6X5. It provides better surge-current capabilities, less noise and high-temperature operation on vibrator-type power supplies. This unit operates from −65 to +75 C and measures 1.1-in. high and 1.4 in. in diameter. Type 1N570, rated at 1,500-v piv at 75 ma, replaces MIL types 6X4 and 12X4 vacuum tubes in radio, TV, test equipment, computers and data-processing equipment. It measures 0.845-in. high and 0.710 in. in diameter.

International Rectifier Corp., Dept. ED, 1521 E. Grand Ave., El Segundo, Calif.

Price: *ST-8, $13; 1N570, $30.*

Servo Amplifier 553

Requires less than 2 w power

Model 1800-4300 servo amplifier is a transistorized, flush-mounting, 25 w plug-in unit which requires less than 2 w driving power to operate a 60 cps servo motor. The input impedance is 750 ohms, nominal, voltage gain is 6 in the linear region. Power gain is 25 db properly matched and carrier frequency is 50 to 70 cps.

M. Ten Bosch, Inc., Dept. ED, 80 Wheeler Ave., Pleasantville, N.Y.

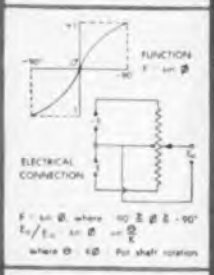
T *otal accuracy*

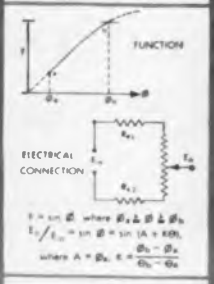
I *nherent reliability*

C *ustomized construction*

NON-LINEAR FUNCTION POTENTIOMETERS

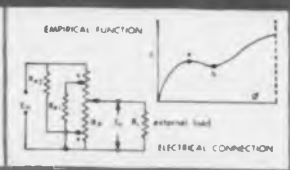
$R = f(\theta)$





Whenever you have potentiometer applications calling for resistance variations other than linear, turn to TIC for the solution to your problem. TIC non-linear function pots are offered in 14 standard types — 7 servo units, 6 panel controls, and a rectilinear unit. To meet your most critical needs TIC also produces special windings, including sine-cosine pots, all of which incorporate TIC's patented double-contoured resistance element card.

Among the uses of TIC non-linear pots are as panel controls components of servo-mechanism computing elements, and position transmitters in feedback control systems in a wide variety of equipment. Because of the versatility of TIC precision pots, these non-linear pots can be included as a cup in a ganged assembly made up of linear functions, other non-linear functions, switches, commutators, clutch-spring return mechanisms, and clutch-brake modules.



TIC non-linear function pots provide years of dependable, trouble-free service . . because they are the quality-controlled products of the leaders in design and development of the most complete line of pots.

Write, telephone or wire for new catalog

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CIRCLE 143 ON READER-SERVICE CARD

MICRO-MINIATURE RELAY STYLE 6A

For Printed Circuits

Less Space

Lower Mounting Height

Terminals & Mounting Conform to 0.2" Grid Spacing

For reliable switching of low-level as well as power loads. Style 6A will operate at coil power levels below most larger current-sensitive relays in its general class, yet easily switches load currents of 2 amps resistive and higher at 26.5 VDC or 115 VAC. Contact arrangement to DPDT.

Unique construction permits flexible wiring and a variety of schematics. Withstands 50 G shock and 20 G vibration to 2000 cycles.

Meets applicable portions of specifications MIL-R-5757D and MIL-R-25018 (USAF) Class B, Type II, Grade 3.

Call Or Write For Additional Information

PRICE ELECTRIC CORPORATION

302 E. Church Street • Frederick, Maryland
MOnument 3-5141 • TWX: Fred 565-U

CIRCLE 144 ON READER-SERVICE CARD

NEW PRODUCTS

Germanium Transistors 527

For computer switching

These 2-pnp type germanium transistors are designed for switching applications in data-processing systems. Type 2N414, for medium-speed switching applications, is an alloy-junction type with a high collector-current rating of 400 ma and a dissipation of 150 ma max. Its typical alpha-cut-off frequency is 8 mc; typical beta (h_{fe}) is 80 at -6 V_{ce}. Type 2N1450 is a drift-field type for non-saturating high-speed switching application. Turn-on time is 100 μsec max; turn-off time is 85 μsec max. It will operate at pulse repetition rates up to 10 mc. Dissipation is 120 mw max. Its package is JEDEC TO-9; that of the 2N414 is JEDEC TO-5.

Radio Corp. of America, Semiconductor & Materials Div., Dept. ED, Somerville, N.J.

Tape Equipment 535

Reproduces punched tapes

A tape reproducer that duplicates punched paper tapes at the rate of 150 characters per sec, and a translator that reads punched tapes at 600 characters per sec are the basic units of Facitape. Capacitance readers, free of environmental interferences, are used. The punch can be used with all tape materials, in up to 8 channels. The reader uses 140 w, has positive braking action and will stop within a character. The 2 units may be had in a console that is 48 x 34 x 30 in., weighing 125 lb.

North American Aviation, Inc., Autonetics Div., Dept. ED, 9150 E. Imperial Highway, Downey, Calif.

Film Insulation 536

Dielectric is 4,000 v dc per mil

Made from glass microfibers and Teflon, this film insulation operates in temperatures of 200 C to 250 C and has a dielectric of over 4,000 v dc per mil. It is available in non-porous form in thicknesses from 0.8 mil to 1.7 mils, and in porous form in thicknesses from 0.9 mil to 13 mils.

American Machine & Foundry Co., Amflex Products Dept., Dept. ED, Springdale, Conn.

Wirewound Resistor 534

Is temperature-compensated

The Tempensator is a wirewound resistor containing an integral, individually calibrated, temperature compensating network. Total temperature variation over the range of -55 C to 125 C is between 0.01% and 0.03%.

National Resistance Corp., Dept. ED, Walter St., Pearl River, N.Y.

Pulse Generator 498

Risetime 0.3 nsec

Calibrated, continuously variable pulses of ±100 v max amplitude, at 0.3 nsec risetime, are provided by the model 303 pulse generator. There are built-in, calibrated pulse widths, and fixed and variable repetition rates to 300 cps.

Lumatron Electronics, Inc., Dept. ED, 116 County Courthouse Road, New Hyde Park, L.I., N.Y.

Price: $490.

Digital Modules 499

Have high circuit density

Four identical, independent flip-flop circuits are provided on the 200-kc model TF-101, mounted on a 4 x 4 in. circuit card. Each flip-flop includes set and reset diodes plus AND gates. The module incorporates a 35-pin connector. Gate drivers, diode gates, and other circuits are available in similar construction.

Packard Bell Computer Corp., Dept. ED, 1905 Armacost Ave., Los Angeles 25, Calif.

Price: $110.

Voltage and Phase Comparator 531

For 400-cps equipment

Measurement of in-phase and quadrature voltage components, harmonic content and noise in ac signals around 400 cps can be made with the NAVAPI voltage and phase comparator. In-phase error is less than 0.1% and quadrature error is less than 1.0% of full scale. Reading accuracy in-phase is 0.008% and quadrature 0.08% of full scale. The aluminum-cased unit is protected against humidity.

North American Aviation, Inc., Autonetics Div., 9150 E. Imperial Highway, Downey, Calif.

Spectrum Analyzer 538

Has 1-sec analysis time

The model 4A spectrum analyzer gives simultaneous analyses over a 200-cps range. The instrument, a delay-line synthesized Fourier analyzer, has a 3-db resolution of 1.3 cps. Frequency spectrum of the input signal is displayed on a 5-in. oscilloscope. An attachment positions its frequency coverage at any point in the audio range.

Federal Scientific Corp., Dept. ED, 615 W. 131st St., New York 27, N.Y.

***Price:** $49,800 per unit.*

***Availability:** Six months after order.*

Plotter 547

Has magnetic tape input

Model 3410, plotter system, is designed to convert digital data, recorded on magnetic tape in IBM 704, 709 or 7090 format, into inked or symbol plots on 30 in. x 30 in. or smaller graph sheets. Data may be read directly from magnetic tape. Accuracy is approximately 0.08% of full scale data. Two types of plots may be made: line plots in which successive X-Y points are connected by straight lines; symbol plots, in which one of 12 symbols can be selected and printed.

Electronic Associates, Inc., Dept. ED, Long Branch, N. J.

Precision Trimmer 539

Has 45-turn adjustment

The type SW1/2 precision wirewound trimmer has a lead screw adjustment over 45 turns. Range of the sub-miniature unit is 50 ohms to 50 K, with a tolerance of ±5%. Power rating is 1 w at 50 C. The 1/2 in. square case is 0.197 in. thick. Military standards are met.

TIC of Illinois, Dept. ED, 10130 W. Pacific Ave., Franklin Park, Ill.

Cathode Follower 540

Has own power supply

This compact, portable cathode follower has a self-contained regulated power supply. Its input impedance is more than 1,000 meg; frequency response is ±1%, 1 cps to 500 kc. Gain is 0.98; noise level is less than 20 μv. The 9-lb unit measures 10-1/2 x 5-1/2 x 2-3/4 in., and requires 10 w at 110 v, 60 cps.

United Aerotronics Corp., Dept. ED, Burlington, N.J.

Price: *$266.*

Availability: *10-day delivery.*

Accuracy Is Our Policy . . . . . .

■ The picture which accompanied the text concerning Magnetico's Decade Inductance Models DI-1A, DI-1B, DI-1C and DI-1D (*ED*, Nov. 23, p 89) was incorrect.

■ The New Product release describing Machlett Laboratories, Inc., ultra-violet sensitive vidicon, the UV-522, (*ED*, Nov. 23, p 88) was in error. The specification which read "0.4 μamp per mw" should have been "0.4 μamp per μw." Also, the photo accompanying the text did not show the UV-522.

Frequency Converter Unit 560

Measures from 100 to 510 mc

Frequency converter model 525C is for the firms model 524 B, C or D counters. It allows measuring of frequencies from 100 to 510 mc with 100 mv sensitivity, and signals from 50 kc to 10.1 mc can be amplified with 20 mv sensitivity. The unit contains a capacity-loaded cavity for frequency determination, a diode harmonic generator plus a transistorized amplifier. A "go-no-go" meter on the front panel shows when the signal has enough amplitude for frequency measurement.

Hewlett-Packard Co., Dept. ED, 1501 Page Mill Road, Palo Alto, Calif.

Price: *$425.*

Availability: *10 weeks.*

Coax Connectors 561

These connectors, receptacles and mating hardware are for 50, 70, 93 and 100-ohm impedance coax connectors.

Sierra Swiss Manufacturing Co., Space Age Components Div., Dept. ED, 140 E. Montecito, Sierra Madre, Calif.

Pin-and-Socket Connectors 562

The MD-1100 and 8D-11000 series printed-circuit pin-and-socket connectors are for aircraft, radar and missile applications. They are available in 15 contacts on staggered 0.100-in. centers.

Methode Manufacturing Corp., Dept. ED, 7447 W. Wilson Ave., Chicago 31, Ill.

Screw-Holding Driver 565

The screw-holding mechanism of this screwdriver is actuated by pressure of a finger on the swivelled end. The non-magnetic device releases screws after they are tightened. Interchangeable bits are available in four sizes to fit screw slots of 0.01 to 0.38 in.

Hodat, Dept. ED, 3017 Summit St., Oakland 9, Calif.

Aluminum Containers 566

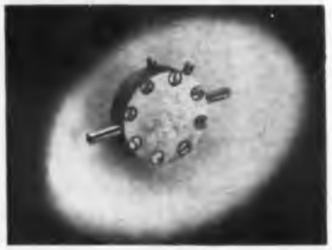
These aluminum containers, in 28 sizes, meet MIL-T-945A and MIL-T-212000 specs. Sizes range from 5-1/4 x 6-3/8 x 4 in. to 19 x 22 x 16 in.

Zero Manufacturing Co., Dept. ED, 1121 Chestnut St., Burbank, Calif.

NEW PRODUCTS

Pressure Transducers 570

For static and dynamic use



The W series of pressure transducers are of the double-coil, variable reluctance, diaphragm type. They can be used for both static and dynamic measurements. Specifications are: excitation voltage, 5 v at 3 to 20 kc; output, from 25 mv for 1/2 psid to 150 mv for 30 psid; range, 1/4 to 60 psid; linearity, ±1% of best straight line or better.

Hidyne Instrument and Engineering Co., Dept. ED, P.O. Box 257, Tullahoma, Tenn.
Price: *$215 ea.*
Availability: *30 days.*

Ac- and Dc-Panel Meters 572

The 1060 series ac-and dc-panel meters have a 5-1/4-in. linear scale that provides exact readings. Accuracy is within 2%. Standard 60-cps frequency-calibration to other frequencies are available.

Hoyt Electrical Instrument Works, Inc., Dept. ED, 42 Carleton St., Cambridge 42, Mass.

Roll-Around Ultrasonic Cleaner 575

This roll-around ultrasonic cleaner is a self-contained unit consisting of an ultrasonic generator, transducer and counter top. It operates on 115-v. The unit can be used with solvents, detergents, mild acids and alkaline cleaners.

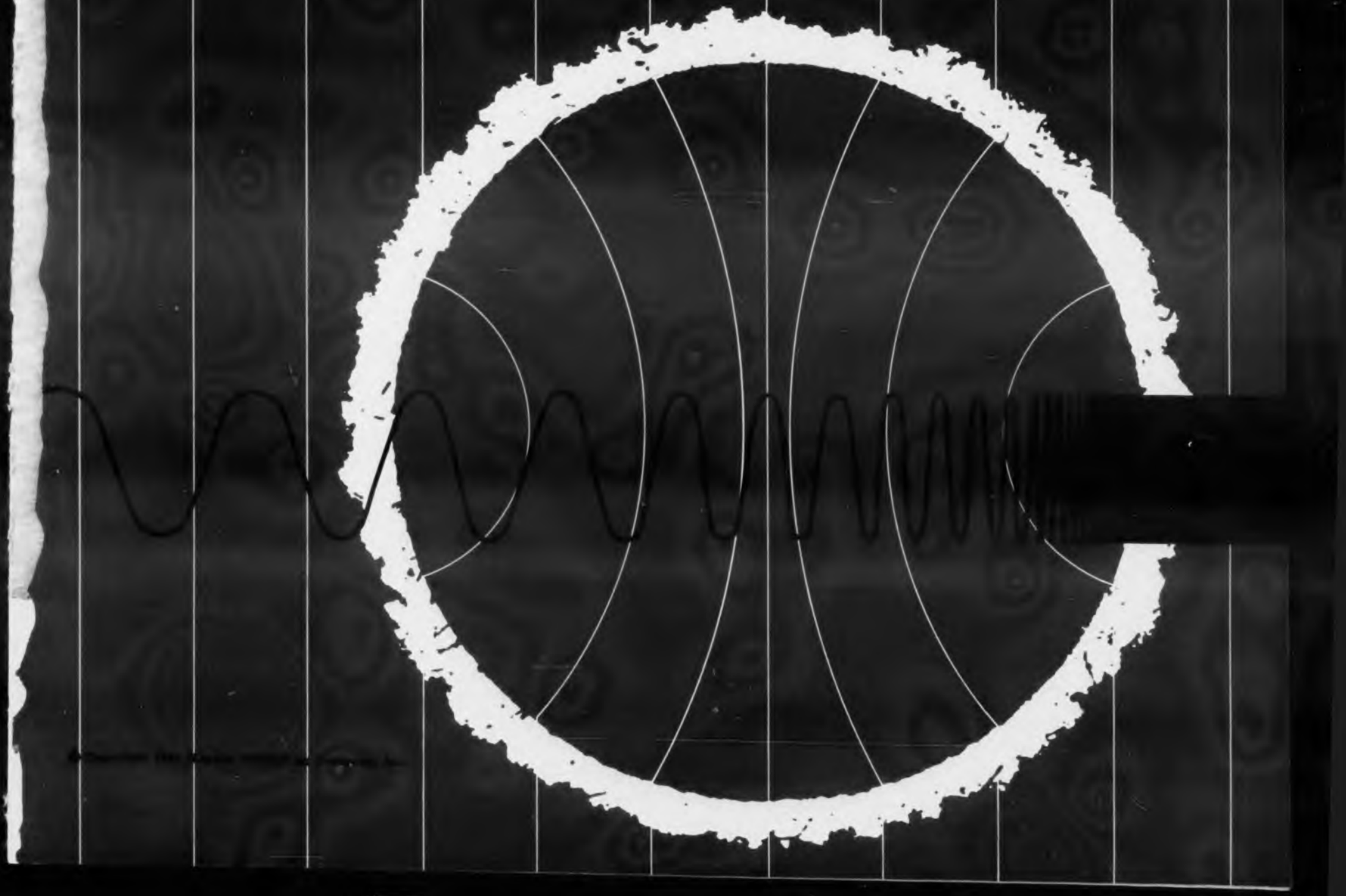
National Ultrasonic Corp., Dept. ED, 111 Montgomery Ave., Irvington, N.J.

Line-Programing Rack 576

Line-programing rack model 254 can cross-patch and/or terminate 2,360 signal lines for data-presentation equipment and data separation. Programing changes are facilitated by a color-coded programing panel and taper-pin connections. Specifications are: cable type, RG-174U; characteristic impedance, 50 ohms; ground system, single-ended common; interconnections, random cross-patching; frequencies, wide-band response; crosstalk, negligible. All rear terminations are located on swinging doors.

E D P Corp., Dept. ED, 3501 S. Orange Blossom Trail, Orlando, Fla.
Availability: *Eight- to ten-week delivery.*

MICROWAVES



MICROWAVES

Section on Microwaves

A survey of microwave engineers' requests for articles has confirmed the editors' evaluation of the information expected by our readers. Strong interest has been expressed in items of current importance to the microwave art, in state-of-the-art pieces and surveys, and in down-to-earth information on techniques of design, production and testing.

These categories closely parallel the make-up of ELECTRONIC DESIGN editorial. Complying with our readers' requests, the regular MicroWaves section of ELECTRONIC DESIGN, scheduled to appear in every second issue, will continue to present a balanced diet of current, significant, and practical information for microwave design engineers.

One of the most serious problems currently facing the microwave industry, and threatening to stifle its growth, is analyzed, from a design point of view, in

A welcome technique that is helping the microwave production engineers to translate complex plumbing designs into precision, stable hardware, is described in

A practical application of plasma technology to the design of a noise generator is presented in

A new variable attenuator with direct digital readout and a direct-readout coaxial wavemeter kick off this issue's selection of

Breaking the Spectrum Strangle—Key to Microwave Growth

WHAT ARE the possible outs from the current situation, referred to by the Senate Committee on Aeronautical and Space Sciences as "clearly, the most pressing communications problem?" The reference is the attempt to stretch a finite electromagnetic spectrum to cover the rising deluge of allocation applications.

The spotlight of a flurry of hearings, dictums, and reactions has reemphasized this basic technical block to microwave growth. Once again, however, it appears that the technical man, not the administrator, holds the key to a real break in this bottleneck. Upon his continued success in answering this problem depends the future of microwaves, as well as that of many enterprises and sciences.

Over the next 40 years, while the world population grows from 3 billion to 5 billion, not one megacycle of useful spectrum will be added to the spectrum. Or perhaps it will be.

The Success of the Past— Can It Be Repeated?

In 1930, the situation was fairly tight. The entire usable spectrum at that time extended from 10 kc to 30 mc. By 1940, the press of necessity had increased the spectrum by nearly one hundred-fold (to 3,000 mc), at the laboratory level. By 1950, the spectrum had again grown, at the laboratory level, several hundred-fold (as high as 100,000 mc).

By this time, actual FCC allocations extended to 30,000 mc, covering a spectrum 1,000 times that of 1930. Even after this phenomenal growth, the Communication Policy Board, established by President Eisenhower, had this to say: "In the face of the growing shortage, the problem of assuring an equitable distribution of the available supply of frequencies among all claimants, both government and private, is rapidly assuming major prominence."

Since that time, advances in single side-band techniques, highly directional point-to-point links, directional broadcast-band antenna arrays and coaxial and waveguide hard lines have had an effect equivalent to expanding the existing spectrum manyfold. And yet, with all these technical advances, the year 1961 brings the same misgivings about the spectrum stretchers' ability to keep ahead of the spectrum users. But is the present situation actually the end of the line?

Further Expansion Possible By Using Frequency, Space, Time, Atmosphere

Without attempting to minimize the problem, the approaches taken in recent announcements drive home the simple fact that the spectrum is a many-dimensional affair. It can be stretched, of course, by increasing the number of frequency bands available. However, this is just one of many approaches.

The spectrum for earth communications can also be increased by converting the two-dimensional earth-surface problem into a three-dimensional problem in space geometry. Furthermore, time-sharing approaches can be effective, as can those approaches which overcome the atmospheric problems.

10,000-Fold Frequency Extension Resulting from New Devices

Extension of the radio spectrum up through the millimetric bands is now a fact at low power levels only.

However, for large power increases at this range, research successes with plasma generators or parallel-driven tube or solid-state millimetric generators must be forthcoming. Indications from the laboratories are that both approaches will probably be practical in a few years.

Promise from a different direction is held forth by the recent successes with infrared and optical masers. Most recent are the announcements of commercially available lasers from TRG and the high optimism recently expressed by IBM for a cw optical maser. Such a development, when practical, could again increase the spectrum, theoretically, several thousandfold.

Satellites and Sky-Stations Will Convert the Problem to 3-D

The FCC rulings notwithstanding, it seems inevitable that one or several proposed methods of lifting the radio-propagation paths off the earth will soon come to pass. Expressions of doubt that satellite links are feasible before 30 to 40 years seem to be melting in the face of successes with Echo and Courier, and announced plans by the Bell System for commercial satellite relays within a few years. Even the stationary-orbit satellite,

Rapid-replacement TWT typifies the design ingenuity necessary to preserve microwave's stake in Bell System's high-reliability satellite relay, due for launching this year.

The spectrum-conserving, 2-in. circular waveguide, under development at Bell Laboratories, will create a "private atmosphere" to transmit 10 times the information now carried by microwave link, with no interference possible.

"ultimate" in communications relays, seems in reach well within the decade, with the Hughes-announced construction of a 32-lb repeater-satellite for this service. The announcement of this 60-channel satellite was one of the highlights of the 1960 ARS meeting in Washington in December of last year.

Even before such satellite relays are in place, the Raytheon-proposed microwave-powered sky-station could provide multi-channel, line-of-sight communication paths hundreds of miles long, without interfering with low-level traffic. Such helicopter-borne stations could make use of millimetric and even optical frequencies in addition to more conventional channels, because of the fact that the transmission path in both cases is above the weather.

Straight-Up Transmission Path Minimizes Interference

In the recent tests with Echo I, interference between the ground-satellite link and nearly ground-to-ground networks was experienced. However, with a separation of 47 mc (or 4.7 per cent), interference-free communication was possible except when the 11-kw transmitting antenna was oriented lower than 1 deg above horizon and within ±10 deg in azimuth of the ground system.

From the point of view of interference problems, the advantage of directly-overhead relays are obvious.

Several attempts over the past month to get a technical comment from the FCC on such interference have met with no comment. However, it seems unthinkable to many others that the present frequency allocations in regard to space can remain as they are. An indication of this thinking is contained in the Oct. 6, 1960, memorandum by the Telecommunications Coordinating Committee addressed to several U.S. companies, saying "the committee agreed that the U.S. cannot enter into firm international agreements until such time as the development of satellite techniques and the frequency needs for satellite telecommunication systems and other space activities can be more firmly established." From this point of view, the element of risk in setting up private microwave links, in terms of early obsolescence of capital equipment, appears to be a real one.

A brute-force method of solving the entire spectrum problem for point-to-point fixed com-

munication is offered in the microwave hard-line. Dr. Stuart Miller, Director of Guided Wave Research at Bell Labs can foresee use of 2-in. circular waveguide in long-line transmission systems within 10 years. Such hard lines appear capable of 10 times the traffic load of radio-link systems. Because of the relatively high attenuation factor (2-3 db/mile), repeater spacing would be about 15 miles, approximately half the average distance of present radio-link repeaters.

Problems Being Explored Include Cost, Need for Proving

Problem areas currently being explored include cost, partially due to close-tolerance waveguide construction in the order of 1-2 mils in cross-section, and 1 mil or better for short-run (2-5 ft) rigidity. This, and the need thoroughly to prove out practical commercial production of these systems, have been partly responsible for delaying introduction to systems. A very high density traffic is needed to make the system commercially feasible.

While not designed specifically to conserve spectrum, the characteristics of hard lines, such as these, give cause to ponder. If ever a relatively low-loss, low-cost microwave hard line were developed, would all fixed point-to-point communications gradually shift away from free-air radiation? One might visualize radio, TV, facsimile, telegraph, rapid-mail, newspaper, etc., all piped into each home very much as electricity, gas and water are now. The impact of such a course of events on the microwave companies would be staggering.

The Unknowns— Could They Change the Picture?

From these current developments, one receives the impression that the spectrum is far from fully saturated. Careful re-allocation, combined with bold foresight, could go a long way in spectrum-stretching.

Beyond these indications, there is the newly developing technique of transmission through the ground. Development of a low-loss optical fiber could make the hard-line transmission of broadband data a reality. Further developments with ultrasonic data transmission through private atmospheres or, perhaps, the basic discovery of some other "spectrum" could change the picture completely. But whether it will or not, only time will tell with certainty. ■ ■

MICROWAVES

Sulfamate Nickel: Boon to Electroformed Microwave Components

A good deal has been said concerning the electrodeposition of metal for the fabrication of very accurate surfaces with complicated shapes. In this microwave production technique article author Brown adds to this progress a new type of metal—sulfamate nickel, admirably suited to the manufacture of microwave parts. The story is told in photographs.

David G. Brown
Technical Director
GAR Precision Parts, Inc.
Stamford, Conn.

ELECTROFORMING, as a production process, has become more and more useful in the fabrication of precision microwave components. As the use of electrodeposition in producing electronic parts has increased, so has the development of special bath formulations in order to meet the requirements of such a highly demanding industry.

The Barrett Sulfamate-Nickel Plating Process[1] is one example of a bath formulation which has found wide use in the electroforming of waveguide parts and components.

Bath Formulation Makes Major Difference In Properties of Nickel Deposits

Electrodeposited nickel from the sulfamate bath has exceptionally low tensile stress without the use of addition agents. Excessively high internal tensile stress of electrodeposited metals can cause blistering, peeling, and cracking of the deposit as the metal builds up on the surface of the mandrel (or matrix). Even if parts were successfully electroformed through the technique, using a high-stressed deposit, the part might eventually fail in service due to warping, distortion, or shrinkage.

Sulfamate-nickel deposits have other engineering advantages over formerly used nickel deposits, some of which are as follows:

- High chemical purity
- Excellent grain structure and ductility
- Good high and low temperature stability
- Excellent machinability
- Good corrosion resistance

The typical range of physical properties of sulfamate nickel is shown in Table 1 on the opposite page.

The sulfamate-nickel electrolyte consists of a concentrated solution of pure nickel sulfamate, buffered with boric acid, allowing a wide latitude of operating conditions. The solution is supplied essentially as a completely purified "ready-to-operate" electrolyte and is simple to maintain. It has low sensitivity to impurities and permits the use of high current densities at low operating temperatures which may reduce plating time by 75 per cent.

GAR Precision Parts, Inc. of Stamford, Conn., one of the largest electroformers of electronic waveguide components, uses the Barrett Sulfamate-Nickel Plating Process extensively in appli-

Fig. 1. Microwave tuning cavity produced with reusable mandrel, holds tight ID tolerances.

Ranges of Properties

Table I

Physical Property	Range
Tensile strength (psi × 10^3)	70-90
Yield strength (psi × 10^3)	60-75
Elongation (per cent in 2 in.)	20-30
Hardness	126-226 (Brinell)
Young's modulus of elasticity (psi × 10^3)	18-22
Coefficient of linear thermal expansion micromin/in./deg F	8.4 (Approx)
Density (g/cu cm)	8.93
Electrical conductivity (per cent, I. A. C. S.)	25
Thermal conductivity (btu/sq ft/ft/hr at 68 F)	50
Melting point (±1 C, ±2 F)	1,455 C 2,651 F

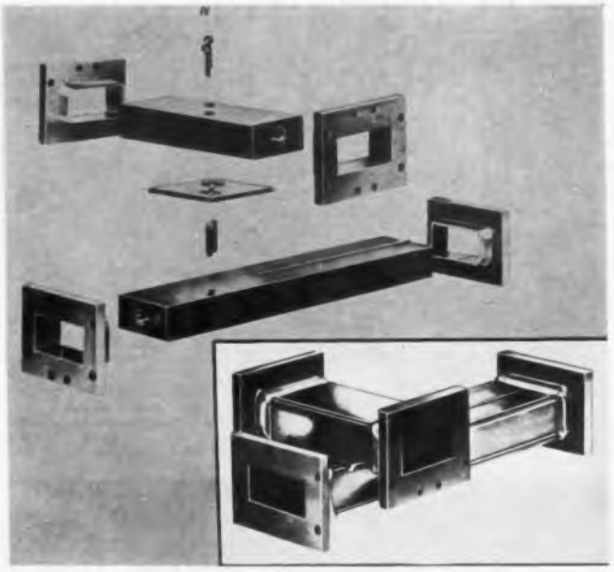


Fig. 2. In this complex coupler, brass and aluminum parts are machined first, nickel is electroformed around them.

cations involved with the use of electrodeposited nickel for engineering purposes.

Reusable Mandrel, Machined to 0.0002 In., Yields Precise, Identical Electroformed Parts

In producing a part by the electroforming process, a mandrel is used to establish the inside shape, dimensions, and finish of the part. Nickel is then electrodeposited on the mandrel to the required thickness, after which the mandrel is removed, leaving the finished part. A reusable mandrel (usually stainless steel) is normally employed wherever part configuration permits mandrel withdrawal. Mandrels can be produced to the most exacting dimensional accuracies (±0.0002 in.) and surface finish (16, 8, 4, and 2 μin.) by conventional metalworking methods since critical areas in the finished part are represented by accessible external surfaces on the mandrel (Fig. 1). Once the mandrel has been prepared, all parts made from it will be reproductions with identical accuracies and finish. Clean, distortion-free separation is achieved by special penetrating treatments of the mandrel surface and thermal withdrawing techniques.

Where part shape does not permit withdrawing the mandrel from the finished part, expend-

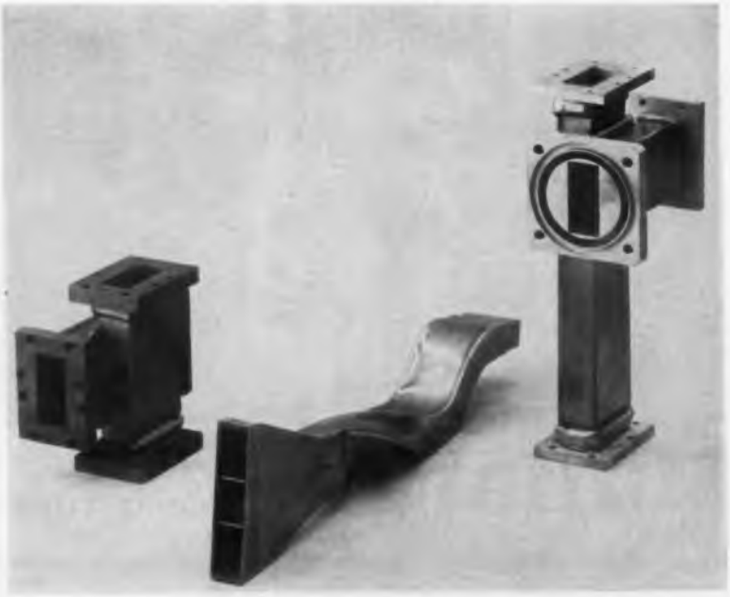


Fig. 3. A cross-coupler, a complex bend and a coupler with choke-flange exemplify the range of unusual forms that can be accomplished with this zero-stress process.

able mandrels are used which can be melted or dissolved out of the interior of the electroform.

A variety of special casting, (Figs. 2 through 8), machining and other methods have been developed for preparing this type of mandrel to insure uniformly accurate part-for-part identity in shape, dimensions and finish.

When outside dimensions must be closely related to inside dimensions of a part, or where concentricity and surface finish of part exteriors are critical, exteriors may be further finished by machining or grinding as necessary. Retaining the part on the mandrel in such cases during subsequent finishing, facilitates work handling, permits finishing extremely thin-walled parts without danger of distortion and provides common close-tolerance centers for inside and outside dimensioning.

Grow-Ins Permit Production of Integral Parts From Several Individual Components

One of the most versatile aspects of electroforming is the capability of producing integral parts from one or more individual components. Such components as flanges, bosses, septums, internal posts, etc., can be affixed to the mandrel in proper position and the electrodeposit formed around and between them to effectively produce a single structural part. Bonds formed between such grown-in components and the electrodeposit are extremely good and in most cases are as strong or stronger than the surrounding metal.

This method permits the use of easy, low-cost external machining for producing otherwise inaccessible and intricate interior part members. The use of grow-ins broadens the variety of materials that can be utilized and can completely eliminate the necessity for brazing or soldering.

Through the proper application and co-ordination of these many special methods and techniques, electroforming with Barrett Sulfamate Nickel is a practical and economical process with many distinct and unique advantages. In a number of waveguide design applications, electroforming has made possible the production of parts unobtainable by any other means. ■ ■

Fig. 4. Here, a double type horn and a single type horn, with and without flange couplings, have been joined to straight waveguide sections by electroforming. Double horn involves grown-in parts.

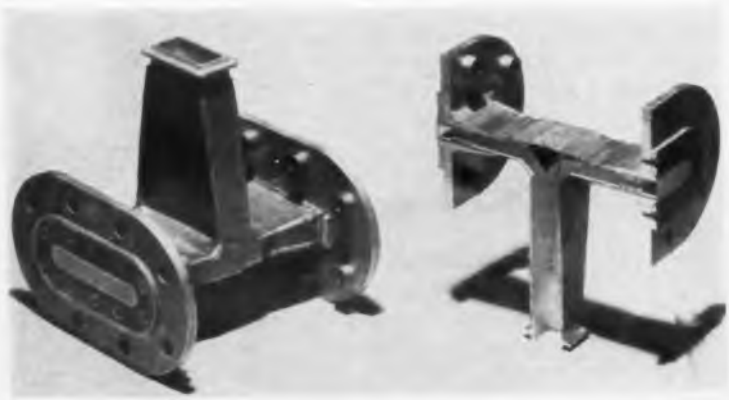


Fig. 5. This complex antenna feed section illustrates the ability to join dissimilar metals. All external surfaces are sulfamate nickel, while internal surfaces are silver, copper and ferrite material.

Fig. 6. This large antenna feed could hardly be manufactured to tolerance by any other type of nickel plating method except the zero-stress sulfamate electroforming process.

Fig. 7. These examples of C-band antenna parts illustrate the complex shapes that can be accommodated, and the ability to work with quartz parts as easily as metal.

Fig. 8. Part of the C-band antenna parts shown in Fig. 7, this threaded quartz window illustrates the bonding of sulfamate nickel directly to quartz.

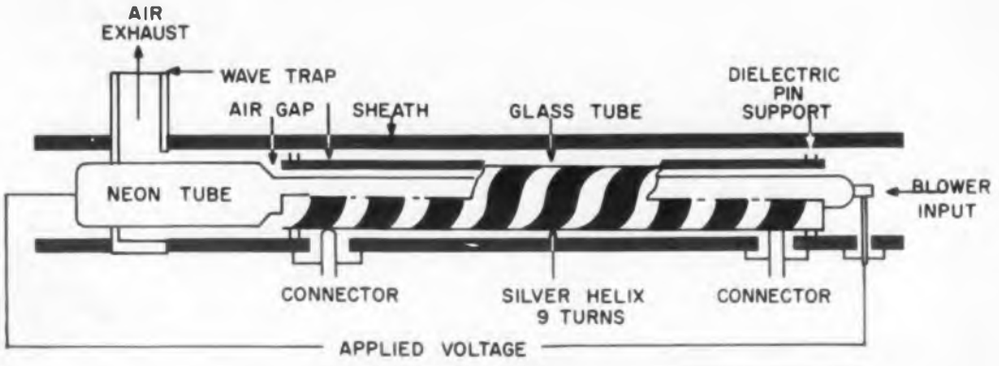


Fig. 1. The simplicity of the microwave noise generator is apparent in this schematic showing the TD-58 neon tube and helix coupler.

Microwave Plasma Noise Generator Uses Air-Cooled Neon Tube

In this article, author Blumenthal describes a simple, inexpensive yet effective plasma noise generator for the 400- to 450-mc region. The heart of the approach is a commercially available neon discharge tube and a properly designed helix to couple the energy into the system.

Dr. Ralph H. Blumenthal
Air Armament Div.
Sperry Gyroscope Company
Div. of Sperry-Rand Corp.
Great Neck, N. Y.

ONE of the simplest and most inexpensive devices capable of producing microwave noise uses a neon-filled tube as a plasma generator. For generating noise in the L_p band,[1] a type TD-58 neon tube, when excited by a steady 200-ma current, will deliver approximately 17 db of noise (above thermal) across the frequency band.

Frequency, Power Per Unit, Bandwidth Reliably Determined By Tube Parameters

The frequency is determined largely by the gas pressure in the tube, which is supplied at 20 mm. Under these conditions, ambipolar diffusion predominates in the positive column. At the same time, the ratio of electron mean free path to tube radius yields a value which permits computation of the effective electron tempera-

ture T_e, as described by Von Engel and Steenbeck.[2] The noise temperature, when multiplied by Boltzmann's constant, yields the power per unit bandwidth of a noise generator. The noise temperature has been shown theoretically and by measurement to be practically equal to T_e in a gas discharge tube.[3]

The ratio of the difference between operating and non-operating temperatures to the non-operating temperature, $(T_e - T_o)/T_o$, when stated in decibels, expressed the relative excess noise power at some frequency f:

$$P_r = 10 \log [(T_e/T_o) - 1] \quad (1)$$

Arbitrarily, the reference point T_o is taken to equal 290 K. The relative excess noise equals 18.2 db for the given tube.

Coupling of Noise To Circuitry Accomplished By Helical Transmission Line

The neon tube is centered within a conducting helix as shown in Fig. 1. Both tube and helix are centered and insulated from a conducting sheath by small insulating pins. The outer sheath is then the outer conductor, and the helix the inner conductor of a helical transmission line. When a steady current is maintained in the tube, the relative excess noise in decibels appearing at the connectors is given by the following equation:

$$P_r = 18.2 + 10 \log [1 - 10^{-(L_h - L_c)/10}], \quad (2)$$

in which

L_h = insertion loss in decibels of the helical transmission line with the discharge tube fired (hot).

L_c = insertion loss in decibels of the helical transmission line with the discharge tube unfired (cold).

The second term in Eq. (2) represents a reduction in output caused by imperfect coupling of helix and gas. This term decreases with increasing tube current.

Design of the Apparatus Emphasizes Heli Design, Cooling

In order to achieve an adequate bandwidth ratio, a proper helix pitch had to be determined. Maximum coupling of the plasma power to the output transmission line is achieved by using a relatively small pitch. At the same time, the separation between succeeding turns must be large enough to prevent arc-over between tubes. The dimensions of the helix and the ratio of helix to sheath diameters are chosen to yield a characteristic impedance of 50 ohms.

The inner diameter of the conducting sheath

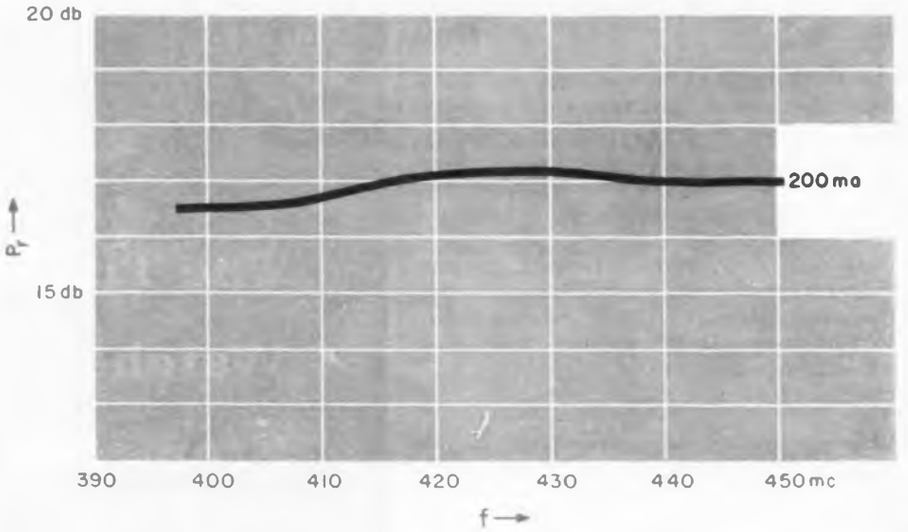


Fig. 3. Relative excess noise power generated remains fairly constant over the entire range of operating frequency.

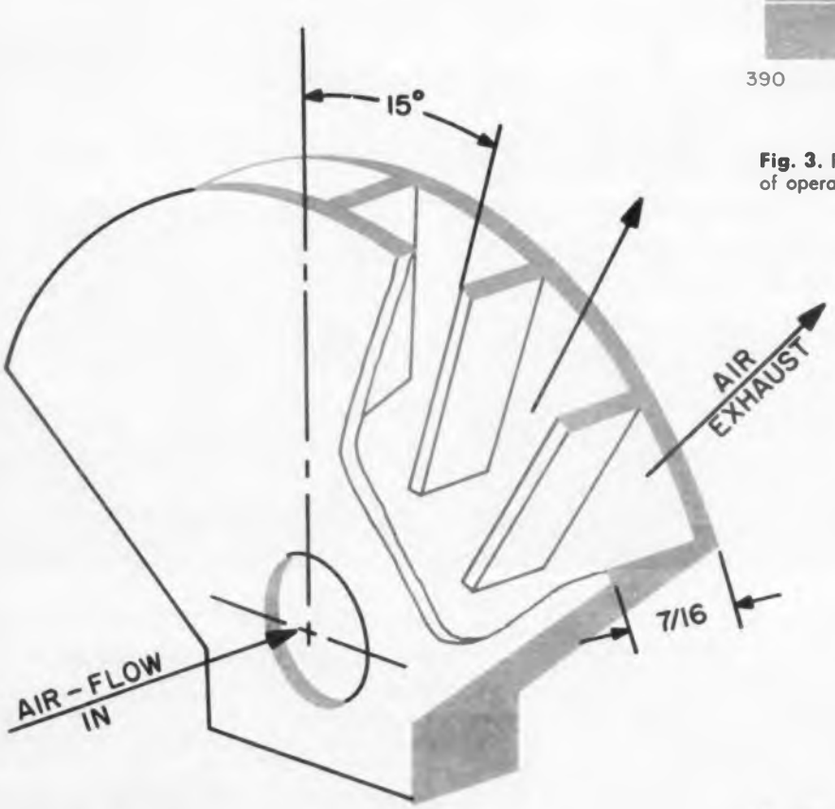


Fig. 2. Cooling air passes freely through this microwave trap, which prevents loss of microwave energy.

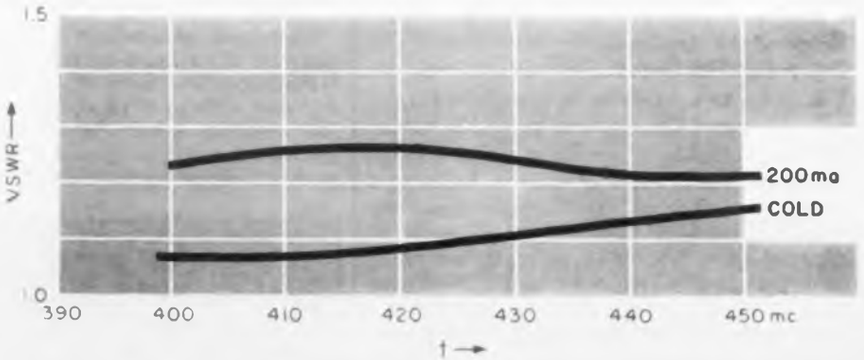


Fig. 4. Operating vswr is relatively low and constant over the operating frequency range.

is 0.703 in. A thin conducting silver helix, one and one-half turns per inch with a tape width of 0.375 in., is plated onto a 7-in. length of No. 7740 glass tubing. The latter has, in the apparatus, an inner diameter of 0.402 in. and an outer diameter of 0.472 in. The helix is coated with a protective molecular layer of silicon monoxide. Experimental results indicate that the manner in which the helix terminates (that is, whether the ends of the helix in contact with the probes are round or pointed) makes no appreciable difference in noise output or voltage standing wave ratio (vswr).

In some applications, noise must be supplied to a device that in turn transmits relatively high power back into the noise source. For these circumstances a blower is used to prevent overheating, as indicated in Fig. 1. The exhaust end terminates in a wave trap (Fig. 2.) The trap is designed to minimize microwave-frequency loss while passing the air coolant. Each exit segment is a waveguide section whose dimensions are below cut-off for L_p band radiation.

The TD-58 discharge tube used as the noise source is a cold-cathode neon tube possessing a heat-resistant envelope. Spring-loaded probe contacts are used in the coax-to-helix transition regions for maximum power-handling capacity. The connectors are type *N* coaxial.

Measurement And Results Of Typical Neon-Plasma Noise Generator

The neon tube is fired by a voltage spike. A steady lower voltage is then applied and a specific operating current maintained in the tube. The relative excess noise is then given by Eq. (2) at specific frequencies over the L_p band. L_A and L_c are the quantities that are measured. A typical plot of P_r vs f is shown in Fig. 3 for a tube current of 200 ma.

Typical curves of voltage standing wave ratio vs f are shown in Fig. 4 for tube current of zero ma and 200 ma. ■ ■

Acknowledgment

The author wishes to express his gratitude to M. S. Tanenbaum of the Sperry Gyroscope Co. for his suggestions in the preparation of this paper.

References

1. The spectral region considered in this paper, 400 to 450 mc/sec, is actually a portion of what is commonly specified as L_p Band.
2. A. Von Engel and M. Steenbeck, *Electrische Casentladungen*, (Springer, Berlin, 1939), Vol. II, pp 86.
3. K. W. Olson, *Trans. IRE Instrumentation*, 1-7, 315 (1958).

MICROWAVES

PRODUCTS

Coaxial Wavemeter 522

Is direct reading through panel aperture

Direct-reading coaxial wavemeter model 1125-6 has a range of 2 to 4 Gc. Accuracy of the transmission-type meter is ±0.1%. Servo or manual drive is optional; an absorption-type meter is available. Other models in this series have ranges between 250 mc and 8 Gc.

Radar Design Corp., Dept. ED, Pickard Drive, Syracuse 11, N.Y.

Price: *$225.*

Availability: *4-week delivery.*

Variable Attenuator 523

Has direct digital readout

These X-band and C-band attenuators give 0 to 60 db attenuation with direct digital readout in db and tenths of db. Both have a vswr of 1.2:1, an insertion loss of 1 db, and a calibrated attenuation range of 0-60 db. Model 780 has a range of 8.2 to 12.4 Gc, an insertion length of 9 in., and a power rating of 25 w; model 783 ranges from 3.95 to 5.8 Gc; its insertion length is 15 in., its power rating 50 w.

The Narda Microwave Corp., Dept. ED, 118-160 Herricks Road, Mineola, N.Y.

Price: *Model 780, $250; model 783, $425.*

Availability: *From stock after Jan. 1.*

Coaxial Switches 519

Provide up to 6 positions

This line of remote-controlled, medium-power, coaxial switches provides 2, 3, 4, or 6 positions with a rating of 500 w at 1 Gc, cw, or 6 kw cw at 30 mc. Maximum rf voltage is 1 kv; maximum current, 1.25 amp surge during switching. The vswr is 1.1:1 max up to 100 mc, and 1.15:1 max to 1 Gc. The 4-3/4-lb switch meets the requirements of MIL-E16400B.

General Communication Co., Dept. ED, 677 Beacon St., Boston 15, Mass.

Ferrite Phase Shifter 521

Is stable to ±5 deg

The model G332 variable transverse field phase shifter has a range from 0 deg to more than 180 deg. At a preset voltage, phase shift settings are maintained within ±5 deg over a temperature range of −20 C to 65 C. Frequency range is 5,550 to 5,750 mc; insertion loss is 0.6 db, and max vswr is 1.30:1. Control voltage is 0 to 25 v, at 200 ma max. Power handling capabilities are 30 kw peak and 30 w average. Similar models can be made available at other frequency ranges.

Lewis & Kaufman Electronics Corp., Cascade Research Div., Dept. ED, 5245 San Fernando Road W., Los Angeles, Calif.

MICROWAVES PRODUCTS

Traveling-Wave Tubes 577

6,000-hr operating life

Guaranteed for a minimum life of 6,000 hr, traveling-wave tube types 55340 and 7537 are designed to operate as broadband amplifiers for use in unattended relay stations. Operating voltages need no adjustment when a new tube is inserted into its mount. For 80% of the tubes, no focus adjustment is needed. Electron-beam focusing is by means of a permanent, uniform-field magnet and the mounts are completely shielded. The tubes are free-air convection cooled. Type 7537 operates in the range of 4,400 to 5,000 mc and can deliver a saturated power output of 6 w. The low-level gain at 5,000 mc, with power output at 100 mw, is better than 34 db. Type 55340 operates from 3,800 to 4,200 mc and can deliver a saturated power output of 8 w. The low-level gain at 4,200 mc, with power output at 100 mw, is better than 37 db. Operating voltage for the 55340 is 1,100 v and for the 7537 it is 1,150 v.

Amperex Electronic Corp., Microwave Tube Dept., Dept. ED, 230 Duffy Ave., Hicksville, L. I., N.Y.

Availability: *30 to 60 days for both types.*

Converter 730

Over-all noise of 1.7 db

This parametric upper-side-band converter has an over-all noise figure of about 1.7 db. The device converts a signal in the region between 350 and 450 mc to 10 kmc and then to an if of 16 mc. A drift cancelled loop is used to minimize undesired effects of pump frequency variations.

General Electric, Communications Product Dept., Dept. ED, Lynchburg, Va.

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Backward-Wave Oscillator 518

Frequency range is 5.2 to 5.8 kmc

The type T15C1C oscillator is for application in high-shock and vibration environments where high-spectrum purity and frequency stability are required. Frequency range is 5.2 to 5.8 kmc at voltages from 1,000 to 2,100 v. Minimum output power is 100 mv. Other models are available for S- through X-band ranges.

Tucor, Inc., Dept. ED, 18 Marshall St., South Norwalk, Conn.
Price: *$3,100 ea.*
Availability: *10 days.*

Microwave Generator 578

Delivers 5 mw min at 2,200 kmc

This solid-state generator delivers 5 mw at 2,200 kmc. Only semiconductor components are used, including a crystal-controlled transistor oscillator and the power source. Two harmonic conversion stages, each using a varactor, are employed to amplify the 116-mc transistor output to 2,200 kmc. The unit has a volume of about 100 cu in.

Philco Corp., Lansdale Div., Dept. ED, Lansdale, Pa.
Price: *$2,465.*
Availability: *Within 90 days.*

Traveling-Wave Tubes 579

For S-band use

These traveling-wave tubes are for use in test equipment and other commercial applications. Type TW-4260 has an output of 1 w min over the range of 2 to 4 kmc. Type TW-4261 delivers 10 mw min and has a 37-db gain over the same range. The tubes weigh 3 lb and have a maximum diameter of 2-1/4 in.

Sylvania Electric Products Inc., Dept. ED, 730 Third Ave., New York 17, N.Y.
Price: *$925.*
Availability: *For evaluation, immediately. Small quantities can be delivered in 60 days.*

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QUANTITATIVE MEASUREMENT OF RESISTOR NOISE

WITH

Model 315 Resistor Noise Test Set

The QUAN-TECH Model 315 Resistor Noise Test set is a highly compact unit for making precise quantitative measurements of excess noise resulting from current through resistors.

Testing with the Model 315 is rapid—operating procedures are simple. Resistors of any type within the ohmic values specified below may be tested. Index of measurement is microvolts-per-volt in a decade of frequency, as recommended by the National Bureau of Standards.

- Conforms to system and specifications recommended by the National Bureau of Standards
- Accepts any type of resistor
- Simple operation; adaptable to production line "go-no-go" use
- Single, compact, bench-size unit

In addition to the front-panel indication, outputs are available for data processing, driving go-no-go indicators, or for external monitoring.

Write for complete details

MAJOR SPECIFICATIONS

Range:	Resistor test range 100 ohms to 22 megohms Noise voltage 0.6 μvolts in a decade to 1000 μvolts in a decade Applied DC voltage 3 to 300 volts
Filter:	Flat-topped, 1000 cycle bandpass. Geometric mean at 1000 cycles
Detector:	Pure RMS
Output:	Indicated for both noise voltage and applied DC voltage on separate front-panel meters. Analog outputs for data processing. AC monitor jack.
Accuracy of Noise Voltage Measurement:	±5%
Price*:	$1550 f.o.b. Boonton, N. J.

*Optional remote measuring cable, $75.00

Quan-Tech LABORATORIES

Boonton, New Jersey

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Microwave Power Divider 582

Has six outputs

This six-way resistive divider consists of seven symmetrical arms, including the input, spaced radially about a hub. The resistive networks provide impedance matching up to 3,000 mc. The unit is electrically symmetrical. It is normally furnished with all female connectors in N, BNC, TNC, C or HN series, but can also be furnished with any combination of male and female connectors. Input and output vswr is 1.2, impedance is 50 ohms and power rating is 2 w.

Microlab, Dept. ED, 570 W. Mount Pleasant Ave., Livingston, N.J.

Price: *$90 to $105.*

Availability: *Immediate.*

Elapsed-Time Indicator 637

Miniature design

The Minichron is claimed to be the smallest available unit of its kind. It is for applications where there is a need to gage and log the actual operation periods of components and equipment. It has no moving parts and very small current consumption. It comes in voltages of 12 or 115 v dc and 115 v ac, with time increments totaling 100, 1,000, 5,000 or 10,000 hr.

SELA Electronics Co., Dept. ED, 545 West End Ave., New York 24, N.Y.

Price: $3.95.

Ku-Band Isolator 722

Handles 135-kw peak, 100-w avg power

Model IKuH8 isolator handles 135-kw peak power and 100-w avg. It covers frequencies from 16,000 to 17,000 mc. Insertion loss is 0.3 db max and isolation is 13-db min and 20-db max. The 2.44-in. long unit, weighing 1.4 lb, has a vswr of 1.06 max. It has choke-type UG-541/U flanges and RG-91/U waveguide.

Availability: 6 to 8 weeks.

Miniaturized Three-Port Circulators 723

For operation in UHF, L and S-bands

These miniaturized circulators are for operation in uhf, L and S-bands. Four basic designs cover the 800 to 4,000 meg band with operation over 10% bandwidths in each range. Insertion loss is less than 0.4 db; minimum isolation is 20 db. All units have a vswr of 1.25 max and have type N female connectors that handle a peak power of 5 kw and an average power of 5 w. Use of type HN connectors on units in the 800 to 1,700-mc range permits handling capabilities of up to 100 kw. Applications include maser, parametric amplifier and radio astronomy, satellite surveillance and other airborne microwave systems.

Raytheon Co., Special Microwave Device Operations, Dept. ED, 130 Second Ave., Waltham 54, Mass.

Price: $425 to $925.

Availability: 3 to 4 weeks.

EXCELLENT form-factor and operating versatility make these rugged magnetrons ideal for many small-package applications including CW or pulsed radar beacons, test equipment oscillators, airborne navigation, proximity detection, surveillance, and transponder type operations.

Light, dependable, and with proven capabilities, these tubes operate at 500 to 600 peak volts and 150 ma peak pulsed current, permitting low-cost modulator components for all applications. They give a nominal power output of 1 watt CW and 15 watts peak.

Engineering programs in progress at Microwave Associates are directed towards development of this tube as a voltage-tunable magnetron within the same form-factor. Your inquiries are welcomed on these and other magnetrons.

A copy of our new 72 page Magnetron Catalog is available upon written request on your company letterhead.

MICROWAVE ASSOCIATES, INC.
BURLINGTON, MASSACHUSETTS

Western Union FAX • TWX: Burlington, Mass., 942 • BRowning 2-3000

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Triode Pulse Tube 654

For radar pulse modulation use

Pulse tube type 6544 is a triode for use in radar-pulse modulation. It features a beamed, oxide-coated cathode structure, a squirrel-cage control grid and a shield grid internally connected to the cathode. Specifications are: heater voltage, 6.0 v; heater current, 60 amp; dc-anode voltage, 18 kv; dc-grid voltage, —500 v; pulse-positive grid voltage, 1,200 v; pulse-anode current, 65 amp; pulse-grid current, 5 amp; load resistance, 225 ohms; duty factor, 0.0015, pulse-power input, 12 kv; pulse power output, 1,000 kv.

Nuclear Corp. of America, Central Electronic Manufacturers Div., Dept. ED, 2 Richwood Place, Denville, N.J.

Waveguide Soldering Alloy 517

Compounded for the soldering of waveguide assemblies, No. 38 self-annealing, tin-base alloy is said to have high creep strength and good wetting. Its low melting range of 428 F to 435 F reduces distortion and prevents surface oxidation.

Alpha Metals, Inc., Dept. ED, 55 Water St., Jersey City 4, N. J.

Noise Source 501

Range is 1 to 4 Gc

The T44S11D noise source, operating from 1 Gc to 4 Gc, has a warranted life of 2,000 hr. Designed for use with 7/8 in. coaxial cable, it has a striking voltage of 1,200 v, an operating current of 50 ma and a noise output of 18.5 db.

Tucor, Inc., Dept. ED, 18 Marshall St., South Norwalk, Conn.

Price: *$450.*

Availability: *30-day delivery.*

Radiation-Density Meter 583

For personal protection

The model B86L1 electro-magnetic radiation meter determines radiation-power densities primarily for the protection of personnel and equipment. Power density can be read directly in four ranges from 0 to 20 mw per cm² over a frequency range of 400 to 3,000 mc.

Filtron Co., Inc., Dept. ED, 131-15 Fowler Ave., Flushing, N.Y.

Microwave Resistance Card Assortment 584

Can be fabricated to desired size

This assortment of microwave resistance cards includes 11 metal-film cards, 2-1/2 x 6 in., a metallized-mica card, 2 x 2-1/2 in., and instructions for fabricating to desired size and shape. Cards may be punched, drilled, machined or sanded. The cards are available in a resistance range from 25 to 750 ohms per square. They are electrically uniform, dimensionally stable, and have a tolerance of ±10% per square. Attenuation to 70 db is possible, and vswr is 1.1. MIL-P-18177 specs are met.

Filmohm Corp., Dept. ED, 48 W. 25th St., New York 10, N.Y.
Price: $40.00 fob New York.

VSWR Monitor 585

For missile applications

A vswr monitor, model SMT-2, qualified for missile flight, utilizes two calibrated crystals to generate dc signals proportional to the incident and reflected rf power. Power capacity is 120 w cw. Output is 50 mv dc with 50 w input. Insertion loss is less than 0.2 db, and vswr is less than 1:05 to 1:00. Accuracy is ±5%; weight is less than 9 oz, and directivity is greater than 25 db.

Sigma Electronics Research Corp., Dept. ED, 15735 Ambaum Blvd., Seattle 66, Wash.

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Leading Telephone Manufacturers Select

VECO VARISTORS

Reliability, ruggedness and accuracy are of the utmost importance in telephone performance—and engineers recognize these characteristics in **Veco Varistors.** Wherever a voltage-sensitive variable resistor can be used, VECO Varistors will fill the bill . . . they're engineered to do the toughest jobs with complete efficiency. Most companies specify **VECO varistors and thermistors,** a further indication of the high regard VECO has earned in the field of thermal and electrical measurement and control.

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Thermistors • Chopperettes • Combustion Analyzers • Thermistor Catheters and Needles • Matched Thermistors • Thermal Conductivity Cells • Thermistor Kits • Varistor Kits • Hypsometers • LOX Thermistors — and many others.

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CIRCLE 170 ON READER-SERVICE CARD

NEW LITERATURE

Alloy Junction Transistors 261

This data sheet describes types 2N1118, 2N1118A and 2N1119 pnp alloy junction transistors. Electrical and physical characteristics are given. Minimum and maximum ratings of the parameters are included. Sperry Rand Corp., Sperry Semiconductor Div., Norwalk, Conn.

Pressure Transducers 262

Bulletins 409 and 509, each two pages, describe and illustrate models 409 absolute pressure transducer and 509 differential pressure transducer. Specifications and dimensional diagrams are given. Bourns, Inc., 6135 Magnolia Ave., Riverside, Calif.

Electronic Filters 263

This brochure gives applications, specifications and selection curves for electronic filters. Deltronics Inc., 1000 Manton Ave., Providence 9, R.I.

Doppler Navigation Systems 264

This eight-page, illustrated brochure gives specifications and describes the firm's capabilities of airborne doppler navigation systems. Laboratory for Electronics, Inc., 1079 Commonwealth Ave., Boston 15, Mass.

Microwave Test Equipment 265

This four-page brochure illustrates and describes the firm's line of microwave test equipment in the WR-51 waveguide size. Specifications, descriptions and price information tables are given. Waveline, Inc., Caldwell, N.J.

DC Power Supplies 266

Bulletin 201, four pages, describes and illustrates four 36-v transistorized, dc power supplies. Features, specifications, and ordering information are given. Krohn-Hite Corp., 580 Massachusetts Ave., Cambridge 39, Mass.

Multi-Deck Switches 267

This two-page data sheet describes series TMB, TMD and TMBD multi-deck switches, designed to provide digital or binary output or a combination thereof. Electrical specifications and dimensional diagrams are given. Chicago Dynamic Industries, Inc., Precision Products Div., 1725 Diversey Blvd., Chicago 14, Ill.

Digital Computer 268

This six-page brochure describes model pb250 general-purpose digital computer. Applications and specifications are given. Packard-Bell Computer Corp., 1905-1907 Armacost Ave., Los Angeles 25, Calif.

Transistor and Diodes 269

This four-page folder gives details of function, performance and characteristics of diffused silicon transistors and diodes manufactured by Fairchild. Schweber Electronics, 60 Herricks Road, Mineola, L.I., N.Y.

400-Cps Chappers 270

Bulletin C-33, four pages, describes series 300 choppers for 400-cps operation. A summary of chopper ratings including electrical characteristics, environmental conditions and mechanical characteristics, and a glossary of chopper terms and definitions are given. Airpax Electronics Inc., Cambridge Div., Cambridge, Md.

High Voltage Triode 271

Bulletin 2160-60, four pages, describes type 7235 high voltage triode. It gives electrical and mechanical data, ratings, absolute values, schematic diagrams and graphs. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Rectifier-Regulator Selector 272

This rectifier-regulator selector gives N.A.E. type numbers for rectifiers or regulators and indicates external configuration and dimensions of these devices. North American Electronics, Inc., 71 Linden St., West Lynn, Mass.

SHOWN 1½ NORMAL SIZE

0.1% LINEAR OUTPUT OVER TEMPERATURE RANGE

SIZE 11 DC TACHOMETERS

These Kearfott DC tachometers are unusually durable and specifically designed to provide reliable service over a long life. R9608-001 is an uncompensated unit ideally suited to function as a stabilizing element in a standard DC servomechanism. The R9608-002 model offers the precision required in computing applications and is temperature compensated to maintain its high accuracy over the temperature range of −15°C to +71°C, with variations of no more than .1% of values specified at 25°C.

		R9608-001	R9608-002
TYPICAL ELECTRICAL DATA	Output (volts/1000 rpm)	7 (typical) .5-30 available	2
	Rated Speed (rpm)	3600	5000
	Linearity (% to 3600 rpm)	.07	.1
	Winding Resistance (ohms)	125	
	Output Impedance (ohms)	—	36
	Ripple Voltage	2% above 100 rpm	2.5% at 3600 rpm
TYPICAL MECHANICAL DATA	Friction Torque (in. oz.)	0.25	0.25
	Rotor Moment of Inertia ($gm\text{-}cm^2$)	7	8
	Weight (oz.)	5.5	5

Write for complete data

KEARFOTT DIVISION
GENERAL PRECISION. INC.

Little Falls, New Jersey

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Modulator Users:

Q. Why does Temco's solid-state radar modulator use the G-E Silicon Controlled Rectifier?

A. "Use of General Electric's Silicon Controlled Rectifier rather than conventional thyratron switching reduces jitter and package size, increases efficiency and reliability."

The first truly solid-state radar modulator, developed by Temco Electronics, a division of Temco Electronics and Missiles Company, Dallas, Texas. Another example of advanced equipment design made possible by use of the General Electric SCR.

Features of the Temco modulator include:

- **Pulse jitter will not exceed 50 μsec.**
- **No adjustment needed before or during use.**
- **Easily meets MIL specs for shock, vibration and temperature.**
- **Automatic fault sensing and reset.**

Now lower-priced than ever before, the SCR opens new areas for engineering development. *Can you afford to wait any longer?* Write today for application data. Rectifier Components Department, Section R23A83, General Electric Company, Auburn, New York.

GENERAL ELECTRIC

CIRCLE 212 ON READER-SERVICE CARD

Power Control System Users:

Q. Why do the newest universal power control units from Magnetic Amplifiers Division of The Siegler Corporation use G-E Silicon Controlled Rectifiers driven by magnetic gating amplifiers?

A. "General Electric Silicon Controlled Rectifiers provide an almost perfect combination of magnetic amplifier and SCR, making possible exceptionally reliable and efficient control of either a-c or d-c power."

Reliability through solid-state design is achieved in small, light weight power control units developed by Magnetic Amplifiers Division. Another example of advanced equipment design made possible by use of the General Electric SCR.

Features of universal power control units include:

- **Precise Control.**
- **High power units up to 2½ kilowatts at a fraction of size and weight of conventional units.**
- **Response of entire system within 1 cycle of supply frequency.**
- **High reliability "designed-in", with no tubes, no moving parts or fragile elements.**
- **Input circuits designed to accept multiple control signals.**

Now lower priced than ever before, the SCR opens new areas for engineering development. *Can you afford to wait any longer?* Write today for application information. Section R23A84, Rectifier Components Dept., General Electric Company, Auburn, N. Y.

GENERAL ELECTRIC

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NEW LITERATURE

Computer Chart 273

This computer-characteristics chart lists 43 general-purpose, stored-program electronic digital computers. The chart gives general characteristics, internal speed, magnetic tape, peripheral equipment and special features of the units. An explanation of column headings, footnotes and an index of manufacturers are included. The reverse side of the chart gives information on the firm's experience and services as electronic-data processing consultants. Charles W. Adams Associates, Inc., 142 The Great Road, Bedford, Mass.

Precision Potentiometers 274

Bulletin 604, four pages, describes series 1500, 1600, 1700 and 1800 precision potentiometers. Dimensional and ordering information, electrical and mechanical specifications, and a list of standard availability values are given. Duncan Electronics, P.O. Box 1953, 1305 Wakeham Ave., Santa Ana, Calif.

Transformers and Substation Equipment 275

Bulletin 960 describes transformers and substation equipment. Descriptions and application data on the firm's line of transformers are given. Sorgel Electric Co., 838 W. National Ave., Milwaukee 4, Wis.

Electrical Power Systems 276

Bulletin PIB-A-9, eight pages, describes electrical power systems for missiles, satellites and space vehicles being flight tested and researched by the firm. It gives analyses, applications and power potentialities of solar thermionic, photovoltaic cell, fuel cell, storage battery, nuclear reactor, thermoelectric and magnetohydrodynamic power systems. A chart shows minimum and maximum power requirements for various space missions and feasible types of power systems for these missions. General Electric Co., Missile and Space Vehicle Dept., 3198 Chestnut St., Philadelphia 1, Pa.

Tantalum Foil Capacitors 277

Bulletin 152G, four pages, describes plain and etched tantalum-foil electrolytic capacitors. A conversion scale is given. Ohmite Manufacturing Co., 3699 Howard St., Skokie, Ill.

Automatic Controllers 278

Bulletin AN-102, four pages, describes the use of various of the firm's instruments as automatic program controllers. Instruments include type F-2 optical line follower and model 2D-5 read-write instrument. Block diagrams are included. F. L. Moseley Co., 409 N. Fair Oaks Ave., Pasadena, Calif.

Subminiature Capacitors 279

Aluminum-foil electrolytic capacitors are described in this eight-page catalog, No. EEM-1500. Engineering data is given. Curves indicate leakage, lifetime, impedance and temperature response. Over 60 subminiature units are listed and illustrated with their capacity and voltage ratings. Barco, Inc., P. O. Box 1222. Milwaukee 1, Wis.

Angular Servo Accelerometers 280

Applications and operating principles of angular servo accelerometers are outlined in this six-page bulletin. Electrical and physical specifications of several models are tabulated. Dimensional drawings are included. Donner Scientific Co., Concord, Calif.

Electronic Welding 281

Volume I, No. 1 of this 8-page booklet entitled "Electronic Welding" describes klystron-production welding. Model 1037 welding head is described and illustrated.

Unitek Corp., Weldmatic Div., 950 Royal Oaks Drive, Monrovia, Calif.

Data Reduction and Automation Systems 282

Bulletin No. 1, nine pages, discusses methods for increasing efficiency of data reduction and automation systems for quality control, continuous processing and large scale experimental work. Diagrams, charts and tables are given. Monitor Systems, Inc., Fort Washington Industrial Park, Fort Washington, Pa.

COAXIAL BROAD BAND FERRITE ISOLATORS

IN SIZES FOR EVERY APPLICATION

Now—from Kearfott, a new and broader line of Ferrite Isolators to satisfy the most exacting requirements of band width and isolation. Combining low unit loss characteristics with compactness and light weight, this new series of Kearfott Coaxial Isolators is available from present stock. Immediate selection and faster delivery is assured *... precision performance proven.*

A FEW OF THE TYPICAL SPECIFICATIONS				
MODEL	FREQUENCY	ISOLATION	INSERTION LOSS	VSWR
C991100-402	1.2—2.6 KMC	10 DB Min.	1.0 DB Max.	1.20
C992100-405	2.0—2.5 KMC	30 DB Min.	.8 DB Max.	1.20
C992100-404	2.0—4.0 KMC	10 DB Min.	1.0 DB Max.	1.20
C992100-407	3.0—3.5 KMC	35 DB Min.	.8 DB Max.	1.20
C993100-401	4.0—8.0 KMC	10 DB Min.	1.0 DB Max.	1.20
C994100-403	7.0—9.0 KMC	25 DB Min.	.8 DB Max.	1.20

Complete information on these or all of the models is available by directing inquiries to: 14844 Oxnard Street, Van Nuys, California, or the sales office in your area.

KEARFOTT DIVISION
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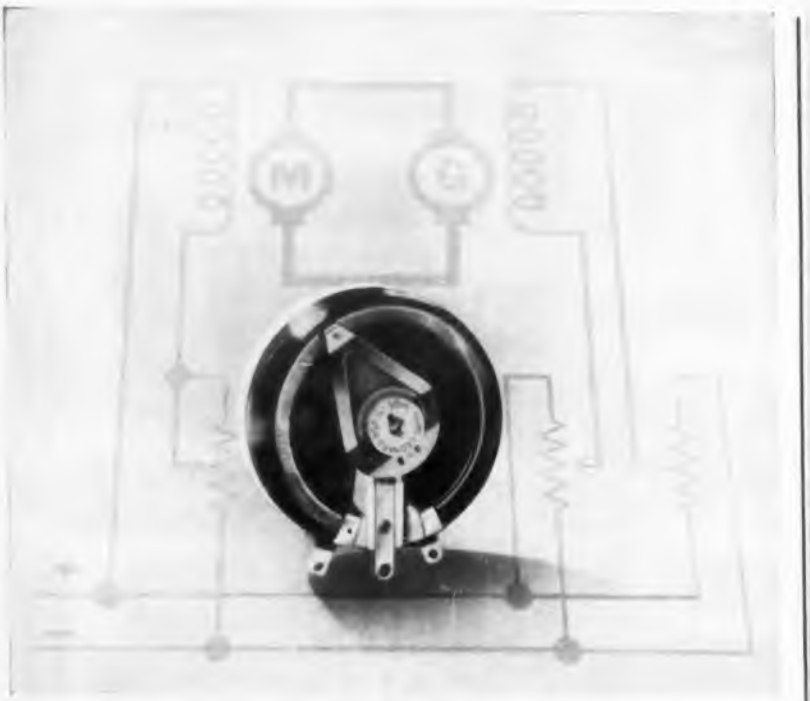
Little Falls, New Jersey

SALES OFFICES SEATTLE, WASH. VAN NUYS, CALIF. PHOENIX, ARIZ. DAYTON, OHIO CLIFTON, N.J. PALO ALTO, CALIF. SAN DIEGO, CALIF. DALLAS, TEX. CHICAGO, ILL. WASHINGTON, D.C.

CIRCLE 177 ON READER-SERVICE CARD



Background is schematic of world-famous Ward Leonard system of control.

In modern rheostat circuits, it's

SERVICE CONTINUITY THAT COUNTS

Production stopped. Workers idle. But wages, maintenance costs, and fixed charges go merrily on accumulating.

That's the black picture when an industrial control component—specifically a rheostat—fails. That's why reliability is more important than initial cost. In many cases, these irrecoverable charges and costs can quickly far exceed the replacement cost of the faulty components.

And that's why far-sighted designers are more and more specifying Ward Leonard VITROHM ring rheostats for control circuits where performance is a must... in motor and generator field control circuits... for electronic tube filament circuits... wherever substantial amounts of power must be handled with utmost rheostat reliability.

Ward Leonard ring rheostats, in sizes of 25, 50, 100, 150 and 300 watts, feature W/L's exclusive "twin contact shoe" design. *Two* sintered, self-lubricating contact shoes minimize wear and assure uniform contact pressure, smooth operation, and maximum reliability.

Special alloy resistance wire—made to W/L's closely monitored specifications to assure highest stability and lowest practical temperature coefficient—is bonded permanently to ceramic core by Ward Leonard's own VITROHM vitreous enamel.

These are just a few of the reasons why VITROHM ring rheostats give you outstanding reliability in industrial control circuits. There are many more quality-engineered features than we can describe here—for instance, highest grade ceramic base and core, durably bonded tinned alloy terminals, and balanced beryllium copper contact arm. You'll find them all in Bulletin 60RR (and for powers above 300 watts, check W/L plate rheostats in Bulletin 60A). For your copy, and for a list of stocking distributors, write: Ward Leonard Electric Co., 77 South St., Mount Vernon, N.Y. (In Canada: Ward Leonard of Canada, Ltd., Toronto.) o.a

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RESISTORS • RHEOSTATS • RELAYS • CONTROLS

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Low-Cost Scope Attachment Traces Transistor Characteristic Curves

Transistor characteristic curves can be easily traced by using the low-cost oscilloscope attachment shown in Fig. 1. It can be connected to any oscilloscope having calibrated horizontal and vertical sweeps. A 400-cps power supply is required. However, the use of this frequency led to a reduction in circuit complexity and, hence, like reductions in size, weight and cost.

Transistors can be tested only in the common emitter configuration. Other user requirements could be met with additional switching. The 4-pole polarity switch reverses the collector supply, bias current, and meter connections as required for pnp or npn transistors. The collector has a half-wave sinusoidal voltage sweep, set with a variable transformer, which is supplied through an isolation transformer. The transformers are selected with combined ratios that yield a peak output of the maximum desired collector voltage, and with a power rating that will accommodate the largest transistors to be tested.

Base bias current is supplied from a 24-v transformer secondary with a filtered, full wave rectifier. This source is controlled by the dropping resistance of a 3-gang potentiometer. This limits the maximum base bias to 100 ma as read on the panel meter. Three current ranges (0-1, 1-10, 10-100 ma) are selected by a 2-pole switch that also

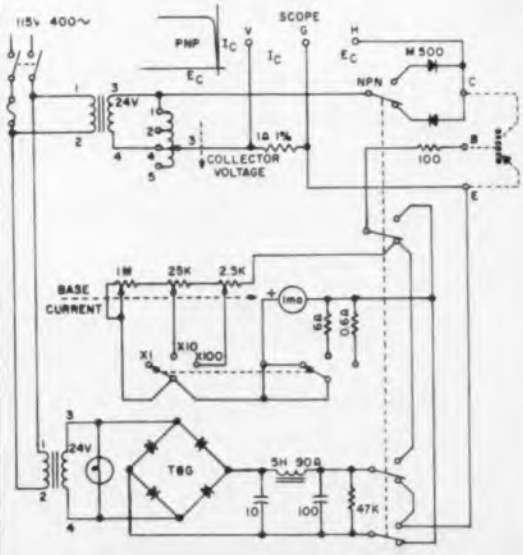


Fig. 1. Transistor curve tracing attachment can be used with almost any oscilloscope.

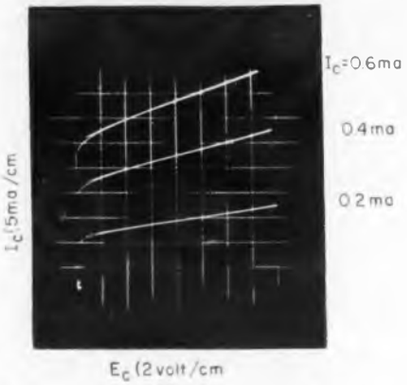


Fig. 2. Characteristic curves for 2N188 pnp transistor are obtained by taking multiple exposure photos for different base current values.

changes the meter shunts. The shunts must be experimentally wound to match the impedance of the 1-ma meter by using a series calibrating meter.

The characteristic curves are presented on an oscilloscope connected to the terminals marked *H* and *V* respectively, and to *G*. A sensitive scope with directly calibrated control knobs (such as a Hewlett-Packard 130A) is particularly convenient for changing scale-factors during the test procedure. The collector current is sampled across a ohm ± 1 per cent shunt, giving a one-to-one correspondence between current and vertical scope deflection. The sinusoidal collector-to-emitter voltage produces the horizontal sweep.

The power is turned on, and the "Collector Voltage" and "Bias Current" controls are turned to the full counterclockwise position. With the polarity switch and "Base Current" switch properly set, the transistor is inserted into the socket, or if more convenient the *C*, *B* and *E* 5-way terminals are used. The characteristic curve will be presented on the scope as a second or fourth quadrant display for pnp or npn transistors respectively. This form of display gives the correct relative sense to the collector voltage deflection while connecting the common emitter to the common ground terminal found on most scope inputs.

Next, the collector voltage is brought up to the desired operating value. The collector current is varied through desired values by adjusting the base bias current. While this is done it is necessary to avoid exceeding transistor ratings. Families of curves are conveniently obtained by resetting the bias control. Multiple exposure photographs can be taken for a permanent record. Shown in Fig. 2 is a family taken for a 2N188 pnp transistor with three different values of bias current.

Chester B. Shapero, Research Engineer, Cupertino, Calif.

PATENTS

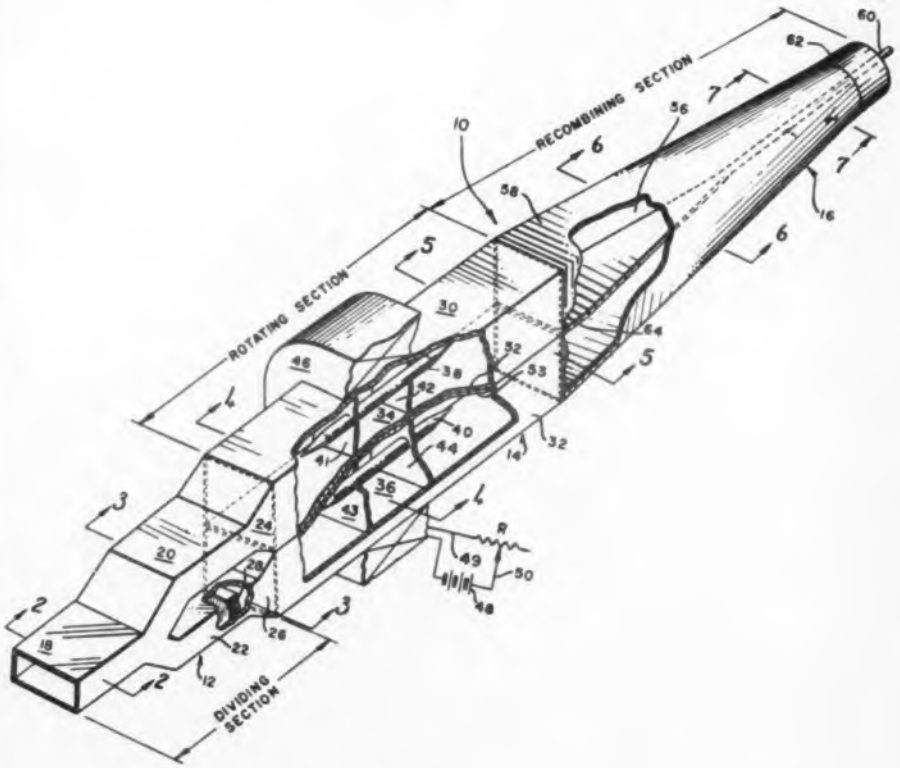
Benjamin Bernstein

Duo-Mode Wave Energy Feed

Patent No. 2,923,897. H. L. Lowhurst. (Assigned to Hughes Aircraft Co.)

The feed to an antenna radiating a cross-polarized beam consists of a coaxial waveguide propagating in the *TEM* and TE_{10} modes, derived from a dominant TE_{10} mode. Power division in the two modes is determined by adjusting the dc magnetic field strength in a Faraday rotator.

In section *12* the TE_{10} mode divides equally, with dielectric plate *28* in path *22* shifting the phase 180 deg. Ferrite rods *38* and *40*, acting with the magnetic field of solenoid *46* adjusted by control *50*, cause Faraday rotation in the two rectangular guides *30* and *36*. In the recombination section, the E_y components combine to form the *TEM* mode of the coaxial wave guide, and the E_x components combine to form the TE_{10} mode. At all times, the sum of the energies of the two modes equals the input energy.

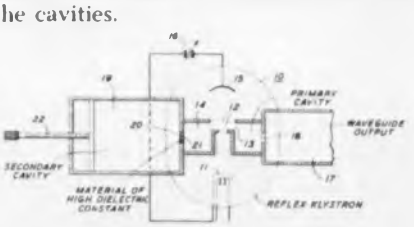


External Cavity Tunes Internal Cavity Klystron

Patent No. 2,944,183. J. Drexler. (Assigned to Bell Telephone Labs)

In a klystron employing secondary cavity tuning, the coupling between the cavities is increased by covering the common wall aperture with a ferro-electric material. This permits the load to couple to the primary cavity so that the oscillator is stable and tunable over a wide frequency range.

A typical schematic shows the primary cavity apertured to the secondary cavity by a small iris which is effectively enlarged by the high dielectric material. The patent shows, in addition, how the voltage sensitive characteristic of the ferr-electric material may be used to change the degree of coupling between the cavities.

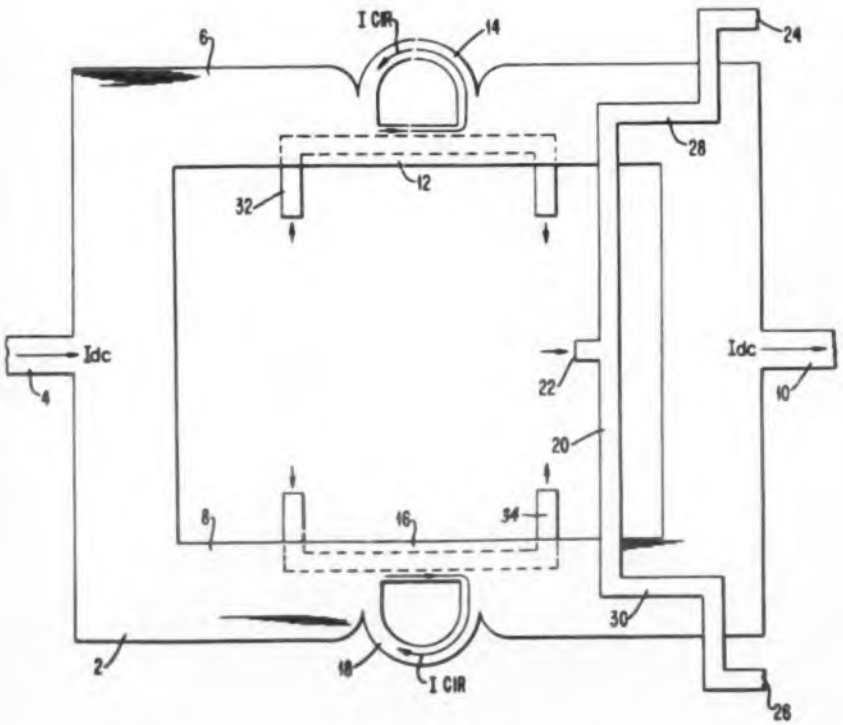


Superconductor Switch

Patent No. 2,930,908. J. T. McKeon, Jr. (Assigned to IBM Corp.)

Two switch arms of superconducting films are made resistive by increasing both the temperature and magnetic field above the critical values.

Assume that current entering terminal *4* flows through the superconducting arm *6* and exits at terminal *10*. This current divides through paths *12* and *14* according to their relative inductances. The circuit begins to switch when a pulse is applied to wire *32*, increasing the current through wire *12* and making this path resistive. Full current also flows through path *14*, making his loop resistive too. The current then switches to superconductive branch *8*, even though branch *6* quickly becomes a superconductor. Loop *20* may be used to sense which branch, *6* or *8*, is carrying the main current.

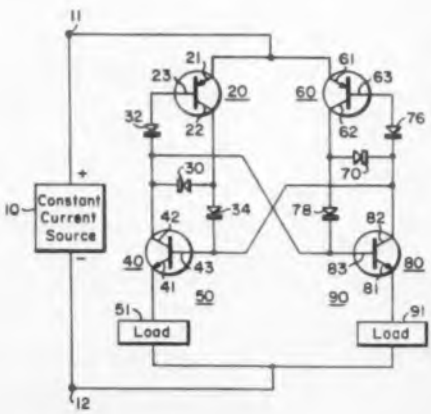


True Current Flip-Flop Element

Patent No. 2,949,549. H. M. Hoge. (Assigned to Westinghouse Electric Corp.)

Two equivalent pnpn transistors are cross-connected to obtain a constant current flip-flop. Operated in the non-saturated state, the switch is relatively very fast.

Npn transistor *40* and pnp transistor *20* are connected, as suggested by Shockley, to simulate a pnpn transistor where base *43* and emitter *41* constitute an electron emitting junction. A symmetrical network comprises npn transistor *80* and pnp transistor *60*. If circuit *50* is conducting, circuit *90* may be triggered 'on' by a positive pulse to the base of the npn transistor, or by a negative pulse to the base of the pnp transistor.



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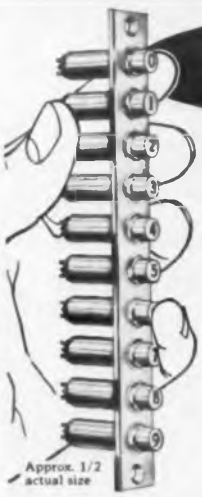

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BOOKS

Microwave Transmission

J. C. Slater, Dover Publications, Inc., 180 Varick St., New York 14, N. Y., 309 pp, $1.50 (paperbound).

This book is written for graduate students and engineers specializing in areas other than microwaves. It is concerned with generators which produce microwaves, receivers which detect them, and the intermediate stage of radiation between antennas. The author discusses such aspects of transmission lines as the infinite line with distributed parameters, the terminated line and reflection, impedance of the terminated line and other problems. Formulas are included.

Noise Reduction

Leo L. Beranek, McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y., 752 pp, $14.50.

The purpose of the book is to present the fundamentals of (sound) noise reduction to engineers who are not specialists in acoustics, but who need information for use in design work. This work was developed from a series of lectures given at M. I. T. A review of fundamentals of noise control is provided. Other topics covered include: instruments for measuring sound and vibration, measurement of sound power levels and properties of porous materials.

Electrical Noise, Fundamentals and Physical Mechanism

D. A. Bell, D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J., 342 pp.

This reference and source book on electrical noise is concerned primarily with the mechanism of noise in physical devices of interest to physicists and electrical engineers. Early chapters review Nyquist's theorem, equipartition, and mathematical and statistical techniques. A chapter on vhf valves covers traveling-wave tubes. The chapter on noise in metal films is of interest to those working in metal-film resistor design. Other chapters may be of value to engineers working in tele-communications, radar, data-transmission, solid-state devices, and other areas.

Wave Generation and Shaping

Leonard Strauss, McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N. Y., 520 pp, $12.50.

The object of this text or reference book is to present a unified approach to the analysis of circuits where the nonlinearity of the tube or transistor is significant. It is assumed that the reader is familiar with the transient analysis of linear networks and with vacuum-type and transistor amplifiers. The material is divided into five sections: models and shaping, timing, switching, memory and oscillations.

The Surface Chemistry of Metals and Semiconductors

Harry C. Gatos, editor; John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 520 pp, $12.

Collected here are the papers presented at the Joint Symposium of the Corrosion and Electronics Divisions of the Electromechanical Society on the Surface Chemistry of Metals and Semiconductors held in October of 1959. The material is grouped into five parts: chemistry and physics of surfaces, imperfections and surface behavior, electrode behavior of metals and semiconductors, surface reactions in liquid media and surface reactions in gaseous media.

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J. George Adashko

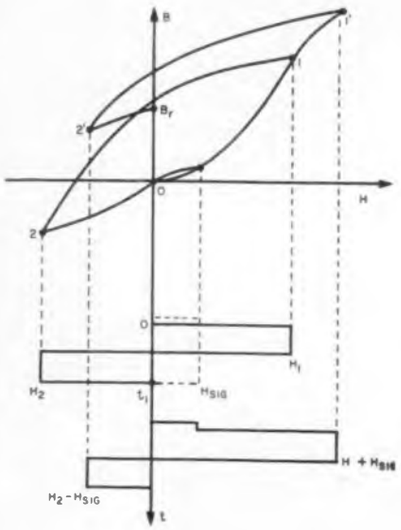


Fig. 1. Waveforms show relation between bias pulse, signal pulse and magnetic characteristic of recording medium.

Recording Short Pulses Magnetically With Pulsed Bias

THE ADVANTAGES of high-frequency bias disappear when short-duration pulses are to be recorded. For example, to record a 0.1 μsec pulse, and to obtain the theoretically required minimum of five to seven reversal cycles, a bias frequency of 50 to 70 mc is necessary. This high frequency would cause large losses in the recording head. Dc bias, because of its poor recording characteristics, could not be used either. In addition, continuous bias (whether ac or dc) is sometimes impossible to apply. This occurs in systems where the recording head, passes, in the absence of a signal, over parts of the recording medium in which some information is already contained. The bias current, can, in this case, destroy the recorded data.

Good recording results, however, can be obtained by using pulsed bias. The bias is produced by a full-wave pulse applied in phase with the signal, Fig. 1. In drawing the waveforms it is assumed that the recording medium is practically stationary during the interval to t_1.

The bias-pulse amplitudes H_1 and H_2 are chosen so that when the bias pulse is applied alone, the medium is demagnetized during the cycle *0120*. When the signal current flows through the head, the signal field H_{sig} combines with the bias field to remagnetize the medium during cycle $01'2'B_r$.

The value of the residual induction is proportional to the signal. Signal-pulse duration can be shorter than the duration of the bias pulse. The relative timing of the signal and bias pulses can also vary. Fig. 2 illustrates the possible relationships between the bias and signal pulses. A recording medium is used which has its maximum sensitivity to the signal in cases *c* and *c'*. Minimum sensitivity is permissible in cases *a* and *a'*.

Actually, recording with pulsed bias of this type has much in common with fixed-bias recording. The pulse H_1 shifts the operating point along the initial magnetization curve, performing the function of erasure. Pulse H_2 moves it along the demagnetization curve, and acts as a fixed bias. The difference in the slopes of these curves produces the different sensitivities in cases *a*, *b*, and *c*.

A block diagram of a setup for recording short pulses on magnetic tape by this method is shown in Fig. 3. The length of the bias pulse t_1 ranges from 0.2 to 0.4 μsec. Tape speed is v = 500 mm/sec. The pulse-signal duration t_p is 0.1 μsec.

The values of U/U_0 were measured for different time relations between the signal and the bias (cases *a*, *b*, and *c*, Fig. 2) and are listed in the table. Here U_0 is the reproduced voltage, measured at the level of the reproduction noise. I_0 is the signal current corresponding to U_0 when recording without bias.

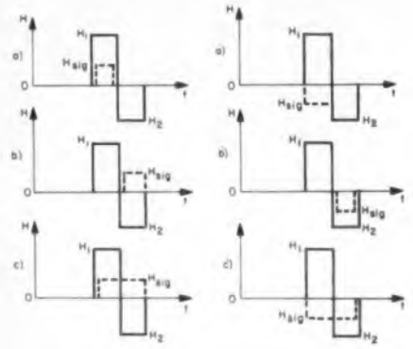


Fig. 2. Six possible phase and duration conditions exist between the bias and signal pulses.

TABLE

CASES SHOWN IN FIG 2	$\frac{U}{U_0}$
a(a')	2 TO 3
b(b')	6
c(c')	7 TO 8

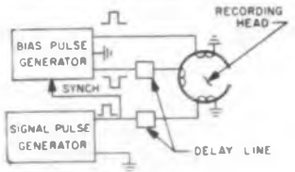


Fig. 3. Block diagram of system for recording short pulses on magnetic tape.

With increasing amplitude of the pulsed bias, the sensitivity of the material increases. However, at large values of H_1 and H_2, the nonlinearity of the recording medium makes it impossible to obtain complete demagnetization in the absence of a signal. In this sense, there exist certain critical values of H_2 and H_1. The optimum ratio of H_1/H_2 is approximately 1.3 to 1.8.

Recording with pulsed bias has the following advantages:

1. The recording of short pulses is improved.
2. Signal pulses shorter than the bias pulse can be recorded, with the loss in the recording head greatly reduced.
3. A sign-reversing pulse of arbitrary waveform can be used.

Pulsed magnetization can also be used in recording systems where the medium is stationary. It permits scanning of the signal, with selection of the signal in time. A magnetic signal amplifier (particularly of the high-coercivity type) can be used as a logical element of the 'and' type.

Translated from "Pulsed Biasing For Magnetic Recording Of Short Pulses," Yu. P. Drobyshev, Radiotekhnika, September 1960, pp. 68-70.

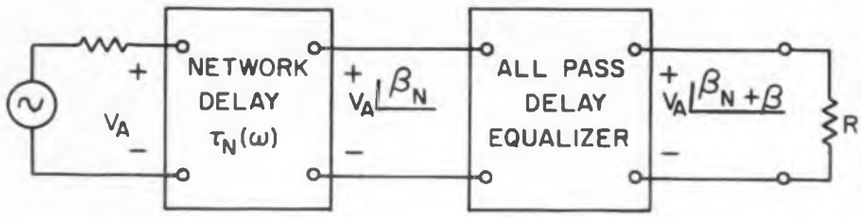


Fig. 1. Cascade phase equalizer.

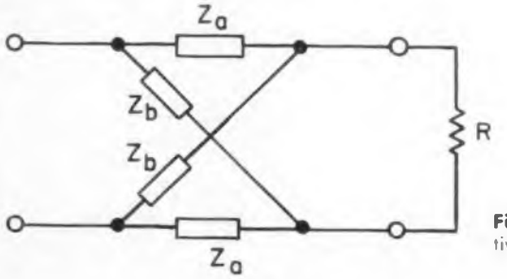


Fig. 2. For $Z_aZ_b = R^2$ the symmetrical lattice with reactive arms serves as a phase equalizer.

Phase Equalizers

THE NONLINEAR phase characteristic of a (low-OR-bandpass) transmission system is compensated for by adjusting the envelope delay time to give constant delay over the required band. If the phase characteristic of a transmission system terminated in a resistance R is β_N, the insertion of a zero-dissipation, all-pass, constant-resistance network between system and termination, Fig. 1, adds the phase shift β, with no change in amplitude response. The total envelope delay time is then given by

$$\tau_r = \frac{d}{d\omega}(\beta_N + \beta) = \tau_N + \tau$$

The constant resistance lattice, Fig. 2, is suited for the design of equalizer networks. For the lattice

$$Z_aZ_b = R^2; \quad \beta = 2\tan^{-1} x$$

$$x = |Z_a|/R; \quad \tau = \frac{2}{1+x^2}\frac{dx}{d\omega}$$

If n identical lattice networks are cascaded, the total inserted delay is $n\tau$.

Where the original system has monotonic delay-frequency characteristics, a first order lattice (where Z_a and Z_b are single elements respectively) can be used. With

$$Z_a = j\omega L; \quad Z_b = 1/j\omega C;$$

$$\omega_o^2 = 1/LC; \; \eta = \omega/\omega_o; \; \tau = \frac{2RC}{1+\eta^2}$$

a system having increasing envelope delay with increasing frequency can be compensated. If Z_a and Z_b are interchanged, the lattice furnishes

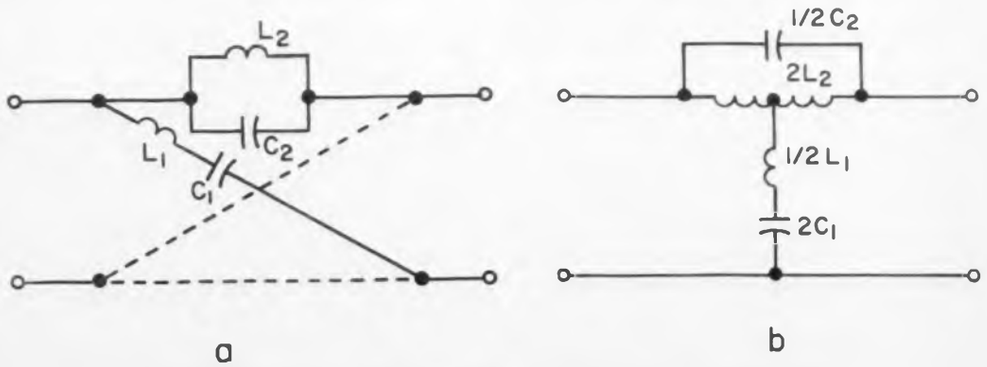


Fig. 3. Second order lattice and bridged-Tee equivalent for envelope delay correct with maximum insertion delay at $\omega_o = 1/L_1C_1$.

increasing time delay with increasing frequency and, therefore, can be used to compensate systems in which τ_N decreases monotonically.

Where the system to be corrected has a minimum of τ_N in the band, the second order lattice (often realized as a bridged Tee), Fig. 3, is used. One sets $C_2 = L_1/R^2$ and $L_2 = C_1R^2$ to obtain the constant resistance property and defines

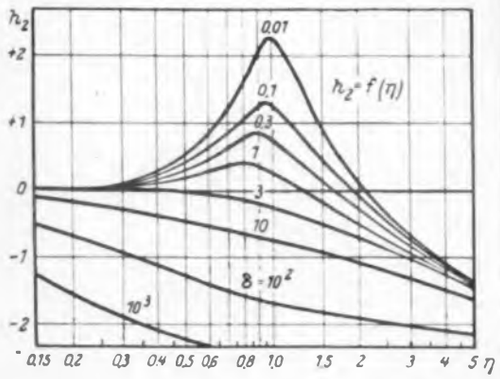
$$\delta = R^2C_1/L_1;\ \eta = \omega/\omega_o;\ \omega_o^2 = 1/L_1C_1$$

Hence $$h_2 = ln\ \tau = ln\ \frac{1+\eta^2}{(1-\eta^2)^2 + \delta\eta^2}$$

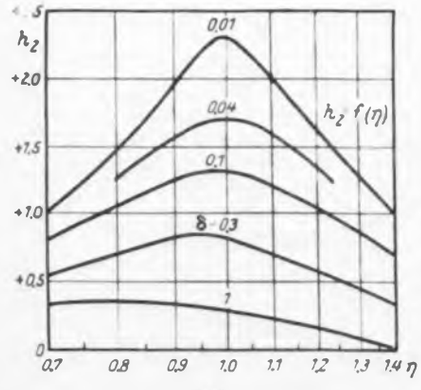
The resulting logarithmic envelope delay function is shown with δ as a parameter in Fig. 4a. In Fig. 4b, the region of maximum delay is shown on an expanded frequency scale. If necessary n networks are cascaded to produce $n\tau$.

The original paper also includes a numerical example in which the design of a two stage, second order lattice in Twin-Tee form is presented for an if amplifier in a TV receiver.

Abstracted from an article by G. Coldewey Frequenz, *Vol. 14, No. 9, Sept. 1960, pp 299-305.*



(a)



(b)

Fig. 4. Envelope and time delay characteristics of the lattice shown in Fig. 3.

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LETTERS

Are NBS Funds Misplaced?

▶ Your editorial "A Fair Week's Work for a Fair Day's Pay" (Aug. 17) is an accurate statement of the critical measurement challenge now facing the United States.

I should like at this time to comment upon another item in the Aug. 17 issue concerning the National Bureau of Standards because I understand there has been some question about it. This is the article entitled "NBS Building Analog-Digital Machine." The question has been raised as to why, if the NBS is hard-pressed, as your editorial states, to keep abreast of demands of measurement and calibration services, it is using limited resources for such things as computer research.

The justification is twofold. First, NBS has for nearly all of its 59 years been looked upon within the Federal government as a general-purpose, physical-science research and service center.

For many years a substantial majority of the Bureau's funds have come in the form of transfers from other government agencies. The analog-digital machine project is one of a variety of important technical service activities carried out for other government agencies in the NBS Data-Processing Systems Division. This specific development is sponsored and paid for by the Navy Department's Bureau of Naval Weapons.

The second justification relates directly to the Bureau's responsibility for the central basis of our measuring system. Adequate measurement standards, and means for their effective use, cannot be provided by NBS without leadership skill in all important areas of physical measurement. More and more advanced measuring processes are employing modern computational or data processing tools.

NBS is actively concerned with improving its own measurement competence through the use of analog and digital computational devices whenever possible. Thus, the analog-digital machine project described in your August 17th issue could be fully justified, if additional justification were necessary, as part of a dynamic, forward-looking program by the laboratory entrusted with responsibility for national leadership in the science of precision physical measurement.

Dr. A. V. Astin, Director
National Bureau of Standards
Washington, D.C.

▶ I agree that there is an urgent need for better standards, but must the electronics industry join

the ranks of the Socialists who decry individual initiative and cry to the government to solve all of their problems? There are many politicians who want to preserve the "family farm" and try to do so by keeping the cost of food high and the taxes to the taxpayer and to companies in the electronics industry high.

Since the government also performs research for these farmers, the farmers lose their own initiative in supporting research. If the government did not support this research, then the farmers would band together and form cooperative or other jointly owned corporations to provide for the necessary research. To keep the quality of research high, the farmers would insure that the scientists performing the research were well paid.

I think the analogy holds for the electronics industry. The Federal government has been encouraging small industries in electronics. These small companies obviously cannot individually afford to sponsor their own research to improve standards. The larger companies must supply research in new products and ideas, but, because of the low overhead of small companies, they cannot compete if they also support, individually, research to improve standards.

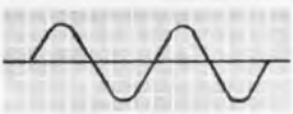
Without government intervention, these companies will ultimately support such a new corporation to accomplish this research—if they are truly losing the sums of money that you claim they are! An enterprising group of scientists could thus, hopefully, prevent a trend to government intervention and Socialism in the electronics industry.

Robert Robbins
Microwave Engineer
Sanders Associates, Inc.
Nashua, N.H.

▶ Ed. Note: Mr. Robbins' opposition to 'Socialist" lack of initiative may be well-founded, but we wonder if his guns are trained on the right target when he equates Electronic Design's stand with a "Socialist" aim of transferring the obligations of industry to government.

Mr. Robbins proposes that large companies support their own research and that small ones band together to sponsor research to improve standards. If successful, this would result in many "standards," which is just about what we have now. But *many* standards make *no* standard.

The vital role which NBS has played includes development of top-accuracy standards of impedance, power, voltage, attenuation, frequency, and other parameters. NBS must continue to improve these standards and must continue as the fountainhead of standards against which all secondary standards can be measured. This is no more socialistic than a centralized postal service.



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Cutting Your Reading Time in "Half"

Knowing how to determine the relative importance of a magazine article, report or business letter is an essential skill in efficient reading. This article will furnish you with a systematic approach to the problem by 'pre-reading.'

Part 2

Myron Q. Herrick
Developmental Research Institute
New York, N. Y.

PRE-READING first saves time. Not every article is of equal importance to you; pre-reading can help to determine the value of everything you read. You can tell whether you want to spend time in a thorough reading, or whether pre-reading will suffice.

Even if a thorough reading is found necessary, pre-reading will still save you time and improve your comprehension. Pre-reading will give you a general idea, before you read, of the content of the article and the author's development of ideas. You will thus be able to concentrate on what the author is saying without wondering why he is making a certain point, or what he is leading up to. Most important, you can adjust your reading speed to the complexity of the article.

1. Look at the title, author and introduction.
2. Next, read rapidly the first couple of paragraphs. These almost always tell you, in a general way, what the author's point is.
3. In the main body of his discussion, begin reading only the first sentence of each paragraph, which almost always expresses the main idea of the paragraph.
4. Glance at pictures, tables and graphs, which will tell more than two pages of print. Note all sub-heads and bold-faced type, which indicate important steps in the discussion.
5. As you reach the end of the article, the first sentences of the paragraphs will tell whether there is a summation. Read any summarizing paragraphs thoroughly but rapidly.

Most magazine editors incorporate many readability features to aid you in acquiring important information in the shortest possible time. The article title summarizes in a few words what you will find in the content of the article. In most cases the titles are followed by what is called the "deck," a short, bold-faced or italic paragraph describing in more detail what the article is about and who wrote it. This allows you to know immediately whether or not, for your purposes, you can (1) skip the article entirely, (2) merely pre-read it, (3) or if it warrants a thorough reading. By taking advantage of these "helps," you will save yourself many hours of wasted time reading material you don't need.

In pre-reading technical books:

1. Note the title, author, and date of publication.
2. Read the table of contents and any introductory material. A look through the index is sometimes helpful in seeing what subjects are treated heavily.
3. Pre-read, and then read rapidly, the concluding and summarizing chapters.
4. When reading the book thoroughly, pre-read each chapter as you come to it.

In reading business letters, a three-step technique will visually tell you if a thorough reading is necessary. The letterhead will tell you where it is from, the signature will tell you whom it is from, and the first sentence will tell you whether the writer is getting right down to business. If he isn't, drop two thirds of the way through the letter for the central point.

Newspaper editorials and book and theater reviews may be pre-read as you pre-read articles. News stories, however, generally contain all of

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the main points in the first few paragraphs. Pre-read a news story by reading the first paragraph thoroughly, and skimming the second and third paragraphs rapidly.

For faster reading of ELECTRONIC DESIGN, for example, spend 10 minutes in pre-reading the entire magazine by first inspecting the Table of Contents. Then check the department that interests you most. If it is Ideas for Design turn to page 160 and pre-read for new ideas. Do this with whatever department is most interesting to you. Then, when you do have time to sit down (even if it's only for half an hour), read the "blurbs" for each article on the contents page, then go on to those which interest you most. Pre-read all of them, and spend the rest of your half hour reading the article which is of most help and interest to you. In 40 minutes then, you have kept up with new developments in your field, you have had a bird's-eye view of the entire contents of ELECTRONIC DESIGN, you have gleaned the major points of two or three articles, and you have read one article thoroughly.

Pre-reading helps you use the techniques of skipping and skimming. If you find that only certain parts of the material are relevant to your purpose, thorough-read only those sections and skip the rest. If it appears that a particular fact you're looking for is contained in the article, skim to find this fact. Skimming means letting your eyes pause—or fixate—only twice on each line, looking for specific facts. This may seem difficult at first, but after practice, you will be able to find the ideas and significant details rapidly. ■ ■

In the first article in this series on cutting down reading time, the author discussed methods for testing your present speed and the technique of phrase-reading as the first step toward faster reading speed.

The next article in the series will deal with improving reading comprehension with faster reading speed.

CAREERS

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YOUR CAREER
NEWS AND NOTES

Teachers of engineering, like others in the academic fraternity, are solving part of their salary problems by doing outside engineering work.

Since 1958, engineering teachers have increased their incomes from outside engineering work 19.7 per cent while their basic teaching salaries increased only 13.4 per cent, according to the most recent of the surveys which are made every two years by the Engineering Manpower Commission of the Engineers Joint Council, 29 W. 39th St., New York 18, N.Y. Total income for engineering teachers increased from an average of $9,598 in 1958 to $11,013 in 1960, a gain of 14.7 per cent, the report stated.

From the figures given in the report, it appeared that those teachers who are at the top of the salary brackets in their categories are able to make the most money on the outside. For example, a professor who made $8,442 could be expected by the statistics to add $664 to his basic teaching salary, but another professor who made $13,230 in teaching could add $6,410 by outside consulting.

The highest total salaries were for deans who could average as much as $18 thousand in teaching and as much as $21 thousand in total income.

• • •

The Soviet Union may appear on the surface to respect and reward technical people more than does the U.S., but one engineer, Raphael Borg, now a New York City consultant, thinks that the comparison has been stretched out of proportion.

Mr. Borg, recently returned from a month's visit to Russia, was interviewed by ELECTRONIC DESIGN. Before he left, he had thought, he said, that the Russian system had certain advantages for engineers. Now that he is back, he thinks that U.S. engineers, who are inclined to use the USSR as an example of how engineers should be treated, had better look elsewhere. He thinks U.S. engineers would receive, as he did, a severe shock if they actually visited Russia and saw first hand the fear and dreariness of working for one vast civil-service organization.

Unlike U.S. civil-servant engineers, who are rarely reticent with their advice on how our government should be reorganized, the Russian engineer is deeply convinced that it is a dangerous waste of time for him to have any "thoughts," Mr. Borg said.

He had, of course, been well aware of the police-state nature of the Soviet Union but had

CAREER NEWS

assumed that this somehow did not apply to technical people. He found, however, that the police-state atmosphere engulfs the engineer on his job as well as others in Russia. This, he said, is because the engineer is working within a rigid civil-service framework. The big problem for the Russian engineer is that there is nowhere for him to go. If his career is stymied by a superior, he can't just pick up the newspaper and find another job.

"It is also a mistake to assume that the Russian engineer is that well paid," Mr. Borg said. Actually, engineering salaries are no more than competitive with general European engineering salaries, which are substantially below U.S. salaries, he said.

As for the free world's technological race with Russia, Mr. Borg feels that the spontaneous creativity of a free-enterprise society is still much better. In the U.S. we have the continual "overnight" formation of companies by bright young engineers who are unhappy with the restrictions of larger companies. Whether these small companies become successful or not they keep the larger companies and the government on their toes.

"The USSR, ironically through its rapid translation and dissemination of U.S. trade publications, is often able to put the spur provided by free-enterprise firms to quicker use than the U.S.," Mr. Borg said.

In conclusion, Mr. Borg said that this country could easily keep ahead of Russia if we got a little of our natural energy off the froth of luxury living (no one starves in this country; there are just many people with Fords miserable because they don't have Cadillacs) and put it into building up our real national wealth.

• • •

Employment of scientists and engineers in industry rose nearly 7 per cent between January, 1959, and January, 1960, the National Science Foundation said in a recent report. This compares to only a 5 per cent rise from 1958 to 1959.

Nearly 40 per cent of the engineers and scientists were engaged in R&D activities (including administration), according to preliminary estimates from the 1960 survey. This represents a significant increase over R&D employment in the previous year, and is undoubtedly related to the greater-than-average growth in scientific employment during the 1959-60 period, the foundation said.

Two industries—electrical equipment and aircraft and parts—each employed around 100,000 scientists and engineers in January, 1960, according to the report.

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Argonne National Laboratory, Professional Personnel Office, Dept. ED, P.O. Box 299, Lemont, Ill.

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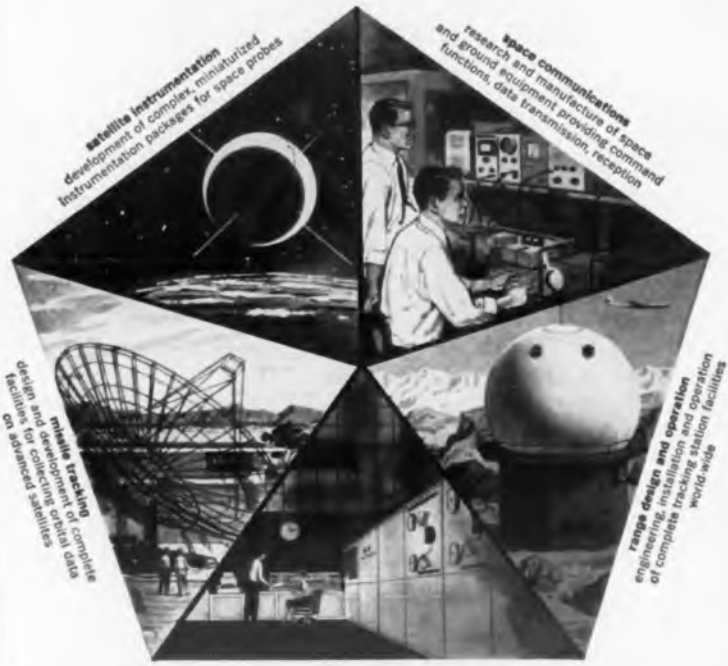

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ADVERTISERS' INDEX

January 18, 1961

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306	316	326	336	346	356	366	376	386	396	406	416	426	436	446	456	466	476	486	496	506	516	526	536	546	556	566	576	586	596
307	317	327	337	347	357	367	377	387	397	407	417	427	437	447	457	467	477	487	497	507	517	527	537	547	557	567	577	587	597
308	318	328	338	348	358	368	378	388	398	408	418	428	438	448	458	468	478	488	498	508	518	528	538	548	558	568	578	588	598
309	319	329	339	349	359	369	379	389	399	409	419	429	439	449	459	469	479	489	499	509	519	529	539	549	559	569	579	589	599
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601	611	621	631	641	651	661	671	681	691	701	711	721	731	741	751	761	771	781	791	801	811	821	831	841	851	861	871	881	891
602	612	622	632	642	652	662	672	682	692	702	712	722	732	742	752	762	772	782	792	802	812	822	832	842	852	862	872	882	892
603	613	623	633	643	653	663	673	683	693	703	713	723	733	743	753	763	773	783	793	803	813	823	833	843	853	863	873	883	893
604	614	624	634	644	654	664	674	684	694	704	714	724	734	744	754	764	774	784	794	804	814	824	834	844	854	864	874	884	894
605	615	625	635	645	655	665	675	685	695	705	715	725	735	745	755	765	775	785	795	805	815	825	835	845	855	865	875	885	895
606	616	626	636	646	656	666	676	686	696	706	716	726	736	746	756	766	776	786	796	806	816	826	836	846	856	866	876	886	896
607	617	627	637	647	657	667	677	687	697	707	717	727	737	747	757	767	777	787	797	807	817	827	837	847	857	867	877	887	897
608	618	628	638	648	658	668	678	688	698	708	718	728	738	748	758	768	778	788	798	808	818	828	838	848	858	868	878	888	898
609	619	629	639	649	659	669	679	689	699	709	719	729	739	749	759	769	779	789	799	809	819	829	839	849	859	869	879	889	899

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Old Company Name ______

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- ☐ I Supervise Design Work
- ☐ I Do No Design Work

ELECTRONIC DESIGN · ONE DAY SERVICE

USE BEFORE MARCH 1st, 1961

D

Name ______ Title ______

Company ______

Company Address ______ City ______ Zone ______ State ______

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290
1	11	21	31	41	51	61	71	81	91	101	111	121	131	141	151	161	171	181	191	201	211	221	231	241	251	261	271	281	291
2	12	22	32	42	52	62	72	82	92	102	112	122	132	142	152	162	172	182	192	202	212	222	232	242	252	262	272	282	292
3	13	23	33	43	53	63	73	83	93	103	113	123	133	143	153	163	173	183	193	203	213	223	233	243	253	263	273	283	293
4	14	24	34	44	54	64	74	84	94	104	114	124	134	144	154	164	174	184	194	204	214	224	234	244	254	264	274	284	294
5	15	25	35	45	55	65	75	85	95	105	115	125	135	145	155	165	175	185	195	205	215	225	235	245	255	265	275	285	295
6	16	26	36	46	56	66	76	86	96	106	116	126	136	146	156	166	176	186	196	206	216	226	236	246	256	266	276	286	296
7	17	27	37	47	57	67	77	87	97	107	117	127	137	147	157	167	177	187	197	207	217	227	237	247	257	267	277	287	297
8	18	28	38	48	58	68	78	88	98	108	118	128	138	148	158	168	178	188	198	208	218	228	238	248	258	268	278	288	298
9	19	29	39	49	59	69	79	89	99	109	119	129	139	149	159	169	179	189	199	209	219	229	239	249	259	269	279	289	299
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301	311	321	331	341	351	361	371	381	391	401	411	421	431	441	451	461	471	481	491	501	511	521	531	541	551	561	571	581	591
302	312	322	332	342	352	362	372	382	392	402	412	422	432	442	452	462	472	482	492	502	512	522	532	542	552	562	572	582	592
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Now RCA Offers TWO Memory Cores for Impulse Switching to 0.2 Microsecond

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Systems Engineering Service: Your local RCA field representative is prepared to furnish a completely coordinated application service, covering transistors and other semiconductor devices, ferrites, and memory systems. Call him today.

Nominal Operating Characteristics At 25°C	Type XF4930	Type 400M1	Units
Read Driving Current (I_H)	570	380	ma
Full Write Current ($I_{F\text{-}W}$)	255	280	ma
Impulse Write Current ($I_{I\text{-}W}$)	130	180	ma
Digit Write Current ($I_{D\text{-}W}$)	125	100	ma
Read Pulse Rise Time (t_r)	0.1	0.1	μsec
Full and Impulse Write Current Rise Time (t_r)	0.1	0.08	μsec
Digit Write Pulse Rise Time	0.1	0.15	μsec
Switching Time (t_s)	0.25	0.2	μsec
Response: "Undisturbed Read-1" (uV_{R1})	100	50	mv
"Disturbed 0" (dV_Z)	15	8	mv
Size	.050x.030x.015	.030x.018x.010	inch

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